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Edited by

THE REV. SAMUEL HAUGHTON, M.D., F.R.S.,
FELLOW OF TRINITY COLLEGE,
AND PROFESSOR OF GEOLOGY IN THE UNIVERSITY OF DUBLIN.

Ὁ βίος βραχύς· ἡ δὲ τέχνη μακρή· ὁ δὲ καίρος ὀξύς· ἡ δὲ πεῖρα σφαλερή· ἡ δὲ κρίσις χαλεπή.—HIPPOCRATES.

VOL. V.

WILLIAMS AND NORGATE,
14, HENRIETTA-STREET, COVENT GARDEN, LONDON;
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1865.

Sci 90.35

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BY M. H. GILL.

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Nº XVII.
JANUARY, 1865.

WILLIAMS AND NORGATE,
14, HENRIETTA-STREET, COVENT GARDEN, LONDON;
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THE

DUBLIN QUARTERLY JOURNAL

OF

SCIENCE.

I.—On the Sea Fisheries of Ireland, and with Reference to Trawling.

By William Andrews, M. R. I. A., President of the Natural History Society of Dublin.

[Read before the Royal Dublin Society, May 23, 1864.]

A meeting was held at the office of Public Works, on the 26th day of March last, for the object of obtaining and receiving such evidence from the men of the trawl boats, and from the hook or line fishermen, as might in some measure modify for each party satisfactory arrangements with refererence to the long-disputed appeals against trawling within certain limits of Galway Bay. As, however, the inquiry terminated in no decided views, I have been induced to submit further notes upon the question.

It is a very difficult point to instil proper views into the minds of those whom prejudice and interested opinions have influenced to volunteer preconcerted statements in support of what they consider just and impartial in their own several cases, or to obtain from them any admission of facts that experience may have taught them. Such instances were strikingly exemplied at the meeting I have just alluded to, and at which no dependence could be placed on the intelligence or on the information of either side.

It is scarcely possible to judge without seeming partiality, or to satisfy minds so imbued; but a decided course, founded upon a proper knowledge of the subject, must result in placing them in their proper positions, without apprehensions of future disputes.

On a visit to London, during the last spring, I accidentally had the opportunity of hearing the fisheries much discussed, especially with reference to Ireland. I regret to say that the views entertained and advanced were not pleasing, nor favourable to this country. It was a country unmanageable—its people indolent, prejudiced, and intractable; and no project for the improvement of the country could with any hope be properly developed; and this bore more particularly on the fisheries, where all attempts through public means or public companies had utterly failed. Even, they asserted, had Irish writers admitted such views. Their arguments, however, were superficial, and their inductions neither sound nor truthful.

Much colouring may indeed have been given to such opinions, when we call to mind the unsuccessful attempts that have been made even so far back as 1838, when a Mr. Davis was managing director of a company with a capital of £300,000, of which capital one-third had been subscribed by five persons in England, for the object of fishing the west and south coasts of Ireland. The means proposed were expensive and complicated, the seat of operations ill chosen; and no results were produced. Equally so was a more recent project, that of the "London and West of Ireland Fishing Company," when the shareholders brought their case before the court, and contended that three-fourths of the capital, £40,000, had since the formation of the company been lost in a few months, the details of which are given in the "Shipping Gazette" of the 18th, and "Saunders's News-letter" of the 20th September, 1857.

The very unfortunate wind-up of what was at one time a most promising investment, before its degeneration into the Royal Irish Fisheries Company (limited), is shown in the "Dublin Gazette" of the 8th of November, 1861. These facts, certainly, give very strong assumptions to their arguments; and when we refer to such statements as given by Mr. Longfield, Q. C., M. P., published late in the last year, in his valuable compilation of the "Fishery Laws of Ireland," and by other writers, we must indeed deplore the apparent melancholy condition of the fishermen of Ireland, and its fisheries. Mr. Longfield, at page 216, informs us—"Nothing can be more disastrous than the present state of the Irish fisheries of all kinds—that of herrings diminished, that of oysters deteriorated, that of salmon declining, the fishermen resorting to the poorhouse, and the boats lying idle on the shore. Naturalists tell us of the wonderful fecundity of fish, and the provision made for their almost exhaustless supply; authentic reports tell of rivers fished out, of shoals of fish diminished or disappearing, and the bounties of Providence wasted and destroyed by man's improvidence."

"Semper tibi pendeat hamus;
Quo minime credas gurgite, piscis erit."

Another, more recent, a work of the present year,—"Mitchell on the Herring,"—gives, whether in ignorance or intentionally, by no means a favourable account of "Irish methods of coast fishing." His views of their capabilities are extremely limited with regard to nets and other appliances, as shown at page 100. On curragh fishing he states—"The curragh, a boat made of hoops, and covered with canvas, is much employed in fishing herrings on various parts of the coast, and even this peculiar antique boat is sometimes not to be had where it could be of use." Again, he states—"An equally striking and unusual mode of fishing is or has been practised in Downing's Bay (county of Donegal)." Here it appears that "the poor people, for want of means, sew their blankets and sheets together, often to the number of sixty, for the purpose of forming an equivalent to a net, each getting a share of herrings in proportion, the people having nothing to cover them when their bedclothes are used in this way." His observations on the effects of trawling, at page 334, are equally absurd, and unnecessarily given.

The foregoing statements have therefore led me to offer some refutation, in explanation of what would naturally appear to be a melancholy state of that branch of our industrial resources, the fisheries; and at the same time I feel called on to justify the proceedings of at least one undertaking for their promotion, and to show how erroneous have been the views so often quoted with regard to it.

The Royal Irish Fisheries Company was formed during a period of deep distress in this country, for the employment and the encouragement of the coast fishermen; and for the promotion of so valuable a branch of industry a Royal Charter was obtained, in June, 1848, through the kind patronage and recommendation of the Earl of Clarendon, then Lord Lieutenant of Ireland, the late Marquis of Lansdowne, and Sir Charles Edward Trevelyan. The first proceedings, and the utility of its operations to the period of its, I may say, degenerating into the "Royal Irish Fisheries Company (limited)," have already been given in papers in this and other societies, and will be found in the "Journal" of this [the Royal Dublin] Society, Nos. 22 and 23, for July and October, 1861. It remains only to give a brief outline of its receipts and disbursements.

Although, through Sir Charles Trevelyan, the Treasury waived the usual heavy expenses attendant on the granting of a charter, yet the ordinary fees of office could not be dispensed with. Towards the attainment of the charter and all preliminary expenses on the formation of the project, and also the outlay necessary for the establishment of a station, and commencing the undertaking, £1034 17*s.* 6*d.* was voluntarily subscribed. Of that sum £377 4*s.* 2*d.* was paid on account of the charter, and sums to the extent of £500 11*s.* 10*d.* were paid for all incidents, and for the formation of the station at Dingle, the total disbursed being £938 3*s.*

It is unnecessary to swell up this statement with minor incidents, on account of testing the fishing grounds, fitting up the stations, &c.; but suffice to say that early in 1849 two trawl boats were added to the company, and a number of canoes and other small craft, which gave employment to a number of men, as well as in the stores. The produce of sales of fish taken from February, 1849, to July, 1854, amounted to £4141 18*s.* 8½*d.*; expenses, for the same period, of agents', fish-factors', &c., wages, purchases of salt, plant, and sundry fitments, were £3655 11*s.* 8½*d.* It may be of interest to state that the returns show, for the above period, the quantities of prime fish taken by the two trawl boats and sent to the Dublin market were—of soles, 74,687 pairs; turbot, 1010; brill, 1631; dory, 974; so that I may say up to July, 1854, the entire working was in a most prosperous state, with a most efficient body of men permanently engaged in the stores and in the boats. Since that period the rates of transit are much reduced, and greater facilities given. The market prices of cured fish are now considerably higher. These results had established a certain success in the undertaking, had provided well fitted-up and commodious stores; and at the time Mr. Stopford transferred to other parties the interest and the established position of the company (the plant being ample), a large store of first quality salt, a stock of well-coopered barrels, and all appliances for the curing of fish, &c., the value was estimated at £3000, that value being largely enhanced by knowledge confirmed and experience gained.

The Royal Charter, granted by her Majesty in Privy Council, was merely in abeyance, the number of shares to constitute it a legal document (owing at that time to the unhappy condition of the country) not having been taken. I am glad to state that the successful results shown were from very limited means, and that by the original undertaking no shareholder was embarrassed, nor shares called in. Good, however, has been effected, by the establishing of an efficient system of trawling, and other improved modes of fishing in Dingle Bay, and which have greatly increased industry and a better knowledge of seamanship among the fishermen. These improvements in trawl gear, nets, long lines, and boats, have since been maintained to the best of their means, and the habits of the fishermen have continued to be industrious and peaceable.

During the time that I was attached to the original undertaking, nearly seven years, all transactions passed through my hands. The returns of agents, the logs of the boats, were each week balanced and inspected; and by practically working with the trawl and other boats at different seasons of the year, a vast amount of practical and scientific knowledge was obtained and confirmed of the habits and seasons of fish, bearings and soundings, and all that information so necessary to command accurate judgment and guidance of the working.

A new element, however, in aid, has come more strongly into operation through the means of "The Trustees for Bettering the Condition of the Poor of Ireland." The funds of this valuable society, of which I have the honour of being a trustee, were formed out of a balance arising from the undisposed of moneys subscribed for the relief of our distressed and starving peasantry during the year of famine, 1822. The objects of that fund having throughout the country been usefully accomplished, it was decided by the "Committee of Management" that the residue remaining in hands should be vested in trustees, and applied to promote the following objects:—

1st. In promoting and encouraging the "coast fishery, both in taking and curing of fish, and that chiefly in affording aid in the construction and repairing of fishing boats; in providing hemp, flax, or twine for the making and repairing of cordage or nets, and procuring hooks, lines, tackle, and other implements used in fishing; and to afford facilities and encouragement to the curing of fish for home consumption."

2ndly. In encouraging the spinning of coarse linen and worsted yarn for the manufacture of articles more immediately in demand for the use of the peasantry; and that chiefly in affording aid to make or repair wheels, reels, looms, &c.; also in procuring hemp, flax, and wool to be distributed where requisite, &c. The London Relief Committee also, with the most liberal spirit, granted sums to be similarly used. The interest of £15,464 8*s*. 3*d*. New Three per Cent. Government Stock, and both principal and interest of £9300 Consols, have for many years past been most advantageously given in loans for the furtherance of those objects, and at present £7000 is distributed throughout the country. The loans are made free of interest, on the recommendation of two approved securities, to be repaid by easy instalments.

Already considerable good has been effected around the coasts of Ireland, among the fishermen and their families, in the districts of Skerries, Balbriggan, Kingstown, Dalkey, Ringsend, &c.; at Greystones, in Wicklow; on the south coast, at Wexford and Youghal; and on the west, at the Arran Islands, Spiddal, Clifden, and Westport, and at the islands of Innisboffin and Innisturk. Considerable sums have also been advanced to artisans engaged at the "loom." In one district, very recently, seventy-eight fishermen have been assisted, with their families, numbering 333 persons. The advances made to promote the fisheries at Howth have been attended with the best results. Thus much distress has been alleviated, and employment given. In the neighbourhood of Skibbereen and Cape Clear the distress of last year was serious. Sir Robert Peel most kindly transmitted £50; but this, distributed among the fishermen of seven hookers and 127 yawls, was but a trifle, and which money had already been anticipated by the kind clergyman who undertook its disposal for such relief. It was distressing that no security could be offered for any loans the society was willing to grant.

But what we chiefly look to is the improvement of the fisheries, by the introduction of large-class boats, suitable to work with safety and comfort to the men in the generally variable and inclement weather of the Irish coasts. By such trawling has been usefully established, and the herring and mackerel fishery in deep water most successfully carried out. I may mention that through the means of the society several of the finest-class boats at Howth, averaging in value with herring and mackerel nets £675 to £700 each, now fish throughout the herring seasons on the east coast, and during the mackerel season on the south coast, from Kinsale to Cape Clear, and from fifteen to seventy miles from the coast. Three of these boats employ eight men in each; and their families, thirty in number, are engaged in net-making and net-mending. The herring fleet at Howth generally numbered—from the Isle of Man, 100 boats; from Scotland, 50; from Cornwall, 300. The herring fishery has been most successful for the last three years. In 1862, eight boats belonged to Howth that were engaged in that fishery. In 1863, there were twenty-six boats, four of them having mackerel trains. The last season was good; the boats averaged a clearance of £15 per week each; one boat had on one occasion a return of £128 in the week. For the season the Howth fleet averaged £120 to £150 to each boat, clear profit. The "Express" paper, 13th June, 1863, states that the success of the Howth herring fishery caused only about one-half the number of barrels of Scotch herrings to be imported. Those who employ the Howth fishermen state them to be bold and skilful seamen, quiet and well conducted, but fond of changing their vessels. The superiority of the Rush and Skerries men as seamen and fishermen has been long well known. In every way the herring fishery has been so successful, that boats of large tonnage are preparing, and, through the enterprise of the Messrs. Montgomery (who speak highly of the facilities given by the Board of Public Works), a fine store is being built on the pier at Howth for the barking of nets, and the storing of fishing-gear, spars, &c. The nets are principally manufactured by loom, in Scotland. Some of the fishermen's daughers earn 10*s*. to 12*s*. 6*d*. per week repairing them.* The large boats are now (May) off the south coast, mackerel fishing. Four are from Howth, twenty-six from the Isle of Man, and twenty-eight from Kinsale. The Manx and Howth nets are worth £170 to £200 a boat; the boats, from £200 to £300 each. The season is generally from March to June, and the fishing has been very successful. The fish are readily sold to fish buyers, who go out in boats to meet the mackerel boats. They pack in ice, and send off all the best fish to England; the remainder have good demand in Ireland. French luggers make good fishing off Cape Clear, and cure the mackerel in bulk early in the season. At so remote a period as 1738, it is recorded that His Majesty's Ship "Lively" off Cape Clear fell in with about fifty sail of large two-masted French fishing vessels, decked, and with thirty-five hands in each. They had long trains of mackerel nets, and they also fished with lines for cod, hake and ling. They were on the soundings of the Nymph Bank. Mr. Philip Hoare, of Boot-lane, was kind enough to send me the account of the take of one of the Manx luggers, which made £167 for the week ending 18th May, 1863; she was a boat of fifty-six tons, with a train of eighty-seven pieces of mackerel nets.

These notes are only with reference to a portion of our herring and mackerel fishery, as I have principally to allude to the craft engaged in trawling and line-fishing. I trust, however, so far will show that Mr. Longfield is not justified in his statements with regard to our herring fishery, nor in his reports of the declining state of the salmon fisheries, and of rivers fished out; for a greater quantity of salmon were taken in the rivers during 1863 than for the previous twenty years.† These observations equally apply to Mr. Mitchell's account of "Irish

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* Messrs. J. and W. Stuart, patent fishing net and twine manufacturers, Musselburgh, whose nets are made by machinery, from the finest quality of Polish Rhine hemp; Messrs. Boswell and Co., of Hawkslaw Works, Leven, Fife, also manufacture superior hemp and cotton herring nets.

† The herring season (1864) has been beyond all former years remunerative and successful.

Coast Fishing;" and whatever might have been the practice half a century since, his views are not applicable to the present time, nor with regard to the curragh. The antique boat, as he terms it, is fashioned in a superior manner, as the beautiful model represents, and is one of the finest open sea boats on the coast, encountering with safety the most formidable billows. The men pull her buoyantly over the long swells of the Atlantic. They are supplied with long lines and hand lines, and the quantities of turbot and haddock, besides ling, cod, and gurnards they bring in from long distances, are often surprising. These canoes are well finished: their length 24 feet, breadth 3 feet 10 inches, depth 1 foot 10 inches, neatly covered with strong canvass, well tarred. The canoe carries four men, each man pulling a pair of light paddles; a slender mast is stepped in the bow, with a lug sail. Hand lines are used, and the long lines are stowed in baskets, about 1800 fathoms of lines, with 1200 hooks. The heavy surf that these canoes brave is accurately shown in the drawing. I have beached on Ballybunnion strand, at the entrance of the Shannon, with a frightful roll from the Atlantic breaking. The drawing (No. 3) represents a heavy roll of the sea, and surf which sometimes breaks on the sandy beaches of Smerwick Harbour, coast of Kerry; and where the Feohanagh or Ballydavid River empties into the bay, a continuous roll of billows breaks on the shore. The headland in the distance is Ballydavid, at the eastern side of Smerwick Bay. The Clare canoes were the finest on the coast; and if Mr. Mitchell had in smuggling times seen the fine hardy fellows pulling to sea to meet the large luggers, he would not entertain such a bias as to their antique character.

We now come to that part affecting more particularly the object of this paper—"Trawling." In the first place, it is necessary that the opinions should be put forward of those who imagine they have adduced the strongest proofs of the evils of such a system of fishing. It may be in the recollection of many the discussion that took place in the House of Commons in June, 1863, on Mr. Fenwick, the member for Sunderland, moving an address to Her Majesty to issue a Royal Commission of Inquiry into our Sea Fisheries, with the view of increasing the supply of a favourite and nutritious article of food for the benefit of the public. In the introductory review he entered most elaborately into the present consumption, even to the number of periwinkles annually eaten by the London community. On comparing similar evils, but which proved erroneous, with regard to salmon, as in no previous year were they so plentiful as in 1863, he notices a number of authorities against those unseamanlike and destructive poachers, "trawlers." His views as to the working of a trawl boat are not very practically given.

Mr. Fenwick first introduces the opinions of Mr. Couch, as one of the first naturalists in the country, who states that "Since the practice of trawling has been introduced into this locality (Cornwall), it is the expressed belief of the (line) fishermen that the produce of the fisherier has greatly fallen off. The destruction of the spawn, spawning ground, and food of young fish, is well known; but precise evidence of this could scarcely be obtained, as all the mess is swept overboard at sea (and the trawlers are too knowing to tell it to shoresmen). The fish are so dreadfully mangled in the trawl net, by being dragged along for miles amid a mass of rubbish, that—Ichthyologist as he was—he could hardly tell what sort of fish they were, and they soon became putrid." The observations of two Billingsgate salesmen are then given who condemn all trawl fish as inferior (forgetful of all the fine turbot and soles they auction off). The opinions of a Cornwall clergyman as to the wholesale destruction of spawn are not worth regard. He next comes to the formidable statements of a captain of a trawler, and of another man, who for the last thirteen years had regularly worked in a North Sea trawler:—" These recount that when the trawl is pulled up, haddocks are found scaled, their eyes knocked out; and other fish with their backs broken, fins gone, gall bladders burst, and fish becoming black and green; plaice with their spots rubbed off, and other damage, besides sweeping overboard as many as 7000 and 8000 unmarketable fish at once. As to spawn, on one occasion (the captain) had three tons in his net, as he estimated by the weight. He had only besides some crabs, and a dozen flat fish." The North Sea man states—" The best test used to ascertain the best fishing ground is the existence of spawn on the ground. The lead is heaved overboard. If it comes up covered with spawn, then the trawl is at once heaved over, and good fishing is expected. The captain considered that a single trawl destroyed hundreds of tons of spawn yearly. The miscellaneous contents of a trawl net were all sorts of fish, spawn, and sea anemones; occasionally the body of a dead man, and portions of bodies, and dead stinking fish killed by other trawls." Such were some among the numerous effusions of trawl garbage with which Mr. Fenwick had to deal, and, with such materials supplied to him, we cannot be surprised at his so earnestly urging the question.

The Rev. R. F. Wheeler, of Whitley, North Shields, gave a lengthy paper in March, 1863, at a meeting of the Tyneside Naturalists' Field Club, being chiefly formed from the replies he had received to the numerous circulars sent out in order that he might be prepared to frame the best means of inquiry either by a Royal Commission or a Committee of the House of Commons.

The greatest of all champions for the hook and line fishermen is Mr. Richard Crick, President of the Fishermen's Committee. His denunciations are strong against the trawl-net:—" The evergaping jaws of this life-destroyer, that receives everything loose in the bottom of the sea—living fish and dead fish, pieces of stone, iron, and coals, masses of sea weed and spawn, and the bones of many a shipwrecked mariner, who lies nine fathoms deep 'in the dark blue sea,' and other relics of the ocean, which the storm has laid beside them, are all jolted along together until the net is filled with this *debris* of the ocean. Five hundred tons of spawn (considerably within the mark) are destroyed in twenty-four hours by four hundred smacks plying on the (south of England) coast." These are the stirring statements that have organized a Royal Commission, who will no doubt see through this *débris*, and will not be deterred from eating a good turbot or a sole so captured.

Those I have just stated are the views of antagonism exhibited by the fishermen of the English coast. It is now necessary to refer to a few that are similarly disposed in this country.

In 1835 an inquiry was held at Kingstown, at which meeting it was stated that the fisheries had considerably diminished in consequence of the number of boats that followed trawling. Mr. Philip Hoare was anxious for the restriction of trawling, as his boats were principally employed in hook or line fishing. He asserted that numbers of undersized fish were sold in the markets, sent in by the trawlers—hampers of small turbot, brill, and dory. Captain Clements was of opinion that trawling was injurious in shoal water, from the quantity of small fish seen in the Dublin market. The quantity of spawn destroyed in the sands was destructive to the fishing grounds. The entire of the evidence of the injury caused by the trawls was so contradictory and self-interested, that it would be of no importance to repeat, nor with reference to the evidence of many other inquiries that from time to time the Commissioners had to listen to.

A few selections from inquiries at Galway, Dingle, and Dundalk, will be sufficient, particularly with reference to Galway, where so much controversy has never ceased to exist. At the inquiry in Galway in 1852, by the Harbour Commisioners and the leading gentry of the place, and at which Mr. Anthony O'Flaherty, member for Galway, and the late Henry Grattan, Esq., M. P., proprietor of the Claddagh, took prominent part, four of the principal fishermen of the Claddagh were deputed by the rest to give evidence. These witnesses swore as to spawn, and to the embryo of fish, and to the young regularly formed, being destroyed by the trawl; and that the young fry of turbot, sole, and brill, were disturbed, as these several species of fish spawned in the whole of the clean ground of the bay down to Arran.

The latest inquiry was that held by Lieutenant-Colonel M'Kerlie, Mr. Le Fanu, and Mr. Barry, Commissioners of Fisheries, on the 3rd December, 1863. At that meeting no evidence—caused through intimidation by the Claddagh people—could be had from the trawling men, but only such given by men of the Claddagh that had been employed in the trawl boats. These men all asserted that large quantities of young fish were taken in the trawl nets, and thrown overboard; that the boats had always large numbers of fry of every kind of fish drawn up in the trawls—cod, haddock, and soles. Anthony O'Flaherty, on being sworn, said he was chief boatman at Barna, and knew the bay very well. The supply of fish had decreased very much since trawling began. In 1852 he went on board a trawler, by order of Mr. Barry, to note the fish taken. Large quantities of fish were taken up which were quite unfit for use. The fishery was not one-fourth as productive from the quantities of small fish taken up. Whiting and mackerel were plentiful at one time, but now they are not to be had. Herrings were frightened away. He was three weeks on board the "Druid" trawler. The boundary line should be removed to Arran. The fishermen do not like to go out for herrings until a certain day, although the fish have been known to be a month in the bay before the men go out. He felt certain that the interests of the public would be served by stopping the trawlers, and leaving the bay to the fishermen. The fry taken up were mostly flat fish—very little round fish.

Mr. Denis Kelly said he was owner of a trawl boat. Trawled in Galway Bay, where the quantities of small fish taken were immense. About half a ton weight of dead fry was thrown overboard every day. Mr. Anthony O'Flaherty, late M. P., bore testimony to the many virtues of the Claddagh people.

At the several inquiries made in Dingle Bay, on the grounds of which the boundary line had been formed, similar evidence was given that the whole bay was spawning ground.

The further investigation held at the Custom House, Dublin, on the 26th March, on the effects of trawling in reference to Galway Bay, was merely to obtain any evidence that may have tended to prove to what extent the fisheries had diminished. No information of importance was elicited from those examined.

The inquiry held with regard to Dundalk Bay, in August, 1862, is a strong proof of the inconsistency of the fishermen. The meeting was convened to rescind the by-law made in February, 1851, against trawling within certain limits. The main evidence was to prove that boats of a certain tonnage allowed to trawl in the shoal water of the bay could not do harm to spawning grounds, and that the fish spawned in deep water. Thomas Carville, of Balbriggan, said he had been a fisherman for the last forty years, with the exception of three years he had been coasting; had trawled all that time in all the bays of the east coast; also was engaged in the herring fishery; both owner and master of a trawl boat of twenty-two tons. Belongs to Balbriggan. His life has been a miserable one since the by-law passed. From his experience, fish spawned in deep water, and came into shallow water to fatten. At this season the shoaler the water, the stronger the fish. White fish did not come into the bay, because there were no trawls to scrape up the ground for them. When asked by a line man when turbot and plaice spawned, his reply was—"When they are ready!" Mr. Good's boats could not trawl in Dundalk Bay, nor in the shoal water off the coast; they drew too much water.

Such are among the very numerous views too often put forward by interested parties, who do not honestly entertain general principles of utility; and too often are such observations more readily supported, to the exclusion of information independently given of results of sound and properly directed investigation.

Now, concisely reviewing the first part of those extracts, we learn from Mr. Fenwick's own statement the enormous quantities of fish sold in the London market during the year 1862. Compiled as far as accurate returns were obtainable, there were sold in Billingsgate half-a-million of codfish, 25,000,000 of mackerel, upwards of 100,000,000 of soles, 35,000,000 of plaice, 200,000,000 of fresh haddock, besides enormous quantities of shellfish, and also inferior fish; and these returns are far short, and are independent of the supplies to all the leading provincial towns—the consumption at Manchester alone being enormous. These returns are far from showing diminution, and which were equally great in 1863.

In Mr. Barry's report to the Commissioners of Irish Fisheries for 1862, of his "Coast of Devon Inquiry," he gave faithful notes of his observations. He was surprised at the prosperity of Brixham, the comfortable clubroom of the fishermen—in this den of the trawlers, where there were 221 trawling vessels, cutter-rigged, and about 100 smaller-class boats, engaged in hook and line fishing, and no bad spirit existing between either class. He learnt from Mr. Saunders, the harbour-master, that there was no diminution in the supplies, and that each year the vessels were increasing, and were improving in equipment.

Mr. Couch's evidence, and that of those who have given such revolting pictures of the action and of the contents of the trawl net, will be sufficiently refuted when explaining the results of experience on the west coast of Ireland. The Rev. R. F. Wheeler appears only to have been animated with the desire of obtaining and presenting to the public the best information he could select from the numerous replies to his circulars. I cannot, however, avoid animadverting on the erroneous views volunteered by Anthony O'Flaherty, chief boatman at the Barna station of the coastguard, before the Commissioners, Lieutenant-Colonel M'Kerlie, Mr. Le Fanu, and Mr. Barry, at the meeting held at Galway in December, 1863. The examination that took place at Galway in June, 1852, has been already alluded to; and Mr. Anthony O'Flaherty, then M.P. for Galway (not the boatman), was well aware of the violence of the Claddagh men in their intention to sink the "Druid" trawler (see "Galway Vindicator," 16th June, 1852), and of the proposition that had been made to place that vessel at the disposal of the Harbour Commissioners for the object of satisfying all parties, by testing the bay. This subsequently led to O'Flaherty, the chief boatman, going out for that purpose. His journal is published in the report of the Commissioners of Fisheries for 1852, page 19. Of the dependence to be placed on that journal I shall explain by giving extracts from the logs and returns that each week were accurately and regularly kept of all incidents connected with the vessel, the weather, and the takes of fish. The 8th July, 1852, was the first day that Mr. O'Flaherty went out, the wind light at west. The steam sloop-of-war "Geyser," Captain Hand, was in the roadstead. Forty-eight pair of soles, two turbot, one brill, and some rough fish—as hake, gurnards, plaice, and dabs—were taken in the trawl. The "Druid" was threatened by Claddagh men in hooker No. 32, and the coastguard man and crew frightened. The week ending 17th July, a midshipman and three seamen went out in the vessel. The "Druid" trawled four days that week. The take of fish was great, also, for the week ending 24th July—out five days that week, and trawled four. At five P. M., 21st July, came-to under Blackhead, landed for water; refused by the natives; plenty of water, but none for the vessel. Week ending 31st July—three days out, large take of fish. In place of being out three weeks in the "Druid," O'Flaherty was not more than three times, took no notes; and whatever returns of fish he had were given him by Tuite, the master of the "Druid." The thick slime on the deck that came off the fish he bottled for examination, and those who tested it can vouch for the fragrance. In the week ending the 7th of August I was at the Arran Islands. On the night of the 4th, and morning of the 5th, fresh breeze at S. W., heavy sea on; "Druid" under two-reefed mainsail and two-reefed foresail. I examined, on board, the fish taken. There were 324 pairs of soles, five turbot, forty-three brill, forty hake, six skate, three dog-fish, and a number of small dabs. Mary soles, or lemon dab (*Platessa microcephala*), and the young of rays, and the flapper skate (*Raia intermedia*), also Muller's topknot (*Zeugopterus hirtus*), but not a single fish that could be termed the young or fry of turbot or soles, nor of cod, haddock, or other white or round fish of value. I have examined carefully the trawl nets, and frequently at different seasons, when out in the Bays of Dingle, Kenmare, and Ballinskelligs, to which I shall presently make reference. In reply to O'Flaherty's other statements, that herrings were frightened by the trawl, and mackerel and whiting not to be had, I refer him to the Galway papers of August and September, 1862 and 1863, which state that the harvest herrings were never so plentiful, nor the take so great. Mackerel must be looked for in deep water; and the herrings were parading the bay, notwithstanding the trawlers, a month before the Claddagh boats would go for them.

Late in the month of November, 1862, I visited Galway, and the Claddagh market. There was a hard frost, and, with an offshore wind, smooth water in the bay. It was Saturday, and the market was glutted with cod, hake, pollock, red gurnard, and dory, selling at the cheapest rates; large cod at 10*d*. each. Any trawl fish taken had been sent to Dublin. The cod fish, although of large size, were of inferior quality. The prime sales of the market were the whiting. I never in any locality saw such splendid fish; they were three to four pounds weight, of fine and firm quality. The Dublin market at that time was supplied for more than a week with such fish during the steady weather. I was fortunate in detecting a whiting not hitherto known on the Irish coast.* These gluts of fish altogether depend upon the weather; for if there are not able boats to stand the sea, scarcity will ensue; hence the perpetual broils against the trawl boats. Mr. O'Flaherty must have very little experience of seamanship, or of the bay, when he maintains that a vessel could work outside the Arran Isles in thirty to fifty fathoms, with a heavy roll of the Atlantic, and with the frequent heavy breezes that even in summer occur. Mr. Denis Kelly's estimate must indeed be light, when he asserts that half-a-ton daily of dead fry had been thrown overboard from his small craft, when the take of a trawl boat of forty-five tons will not average that weight at each good haul of all kinds of fish. I have dwelt thus long on the incidents of Galway Bay, as it is now the quarter perpetually agitated.

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* Couch's Whiting, *Merlangus albus* (Couch).

In continuation, I shall submit some explanatory views.

Such statements of evidence so continuously put forward against the system of trawling were not so much that it had injuriously decreased the supplies of fish, but too apparently on account of the superiority of the vessels so employed, and the great and certain returns that generally resulted. These circumstances combined to keep up prejudices, and to exasperate that class of fishermen who followed less sure means of capture, and who could not compete with vessels of such tonnage and gear. During the period when the largest number of boats were working on the east coast, that were chiefly engaged in hook or line fishing, the boats averaging from twenty-five to sixty tons, many inquiries were instituted as to the supposed injurious effects of trawling. A desire was urged on the part of the line fishermen, that boats with beam trawls should not be permitted to fish within five leagues of the land. The hook or line fishermen admitted that they never could supply the Dublin markets solely by the lines; and that fish, in some seasons, were scarce on many parts of the coast, such as cod, ling, and haddock, even in localities where trawling had not been practised. Prime fish, as turbot and soles, could not at the seasons of their best condition be obtained, but through the working of the trawl boats. It has been suggested that trawling should not be permitted within three miles of the shore. The greater part of the coasts of Ireland are very different from those features that characterize the soundings of the channel of the south coast of England, and the opposite shores of France. In Ireland deep bays and inlets are frequent; with deep water soundings close in with the land. Across the Channel, from the shores of England, and of France, the soundings scarcely exceed the depth for the working of the trawls, taking the ranges from the South Foreland to the Scilly Isles, and from Calais to the Channel Islands.

In order to make the subject more clear, it will be necessary—1stly. To give an outline of the features and soundings of those parts of the east and the west coasts where trawling has been carried on. 2ndly. Class of boats and their equipment. 3rdly. The habits and seasons of fish, ranges and causes of scarcity. 4thly. Hook and line boats, failures with regard to their modes.

1st. I shall not touch upon those parts of the coast to the southward of Bray Head, extending to the coasts of Wexford and Waterford, as no disputes of any moment have taken place with regard to trawling.

The best grounds for the working of the trawl boats are on a long range of nearly ninety miles, extending from Bray Head, Wicklow, to Ardglass, in the county of Down, and varying at distances from the land to thirty miles, where the depth of trawling ground across the Channel to the

Isle of Man does not exceed forty fathoms, and in some eighteen to twenty-five fathoms; at twenty miles from the land, the soundings variable from fifteen to sixty fathoms. Along the entire range of the east coast very valuable charts of the soundings were made for the Commissioners of Irish Fisheries from the surveys of the late Alexander Nimmo, C. E., and also by Commander Mudge, R. N. On reference to them, as well as to the more recent surveys of the coast, although there are extensive reaches of sand, and shoal water in the several bays and inlets from Howth to Dundrum Bay, yet the principal features of the coast are characterized by rocky reefs at different points, running to some distance seaward. Thus we have reefs extending about the rough ground near Lambay in six and seven fathom; lines and patches of reefs off Skerries and Balbriggan, with the well-known Cargee Rocks. Clogher Head sends out its line of reefs, and again off Dunany Point. Several patches with shoal water, off Dundalk Bay, and formidable reefs and patches bound the northern shores of Dundalk Bay and the entrance to Carlingford Lough, the Helly Hunter being well known. Again, northerly to Ardglass, and off Dundrum Bay, extensive reefs and rocky grounds prevail, which are dangerous off Annalong and St. John's Point, and the Bay of Killough. These soundings have been well tested by the experienced trawlers of Dublin Bay, who would not venture to work their large craft along that coast, where the soundings off shore vary from two to six fathoms.

In Dingle Bay similar features of extensive reefs run to some distance into the bay, between the reefs being soundings of sand and mud, varying in depth from five to ten fathoms, the rocky and corally bottoms sometimes having a depth of thirty fathoms. These reefs are at different points bounding the whole of the northern and southern shores of the bay. The same characters present themselves in Galway Bay. The recent surveys are very minute as to the depth of water; but the accurate soundings for trawling and the reaches of clear ground can only be known by the working of the boats, and by the experience of noting bearings. Now, as so much has been argued as to the entire of Galway Bay being spawning grounds, it is necessary more immediately to refer to ranges well known as the ground on which the fish spawn. Westward of the notorious Margaretta Shoal and the Henry Ledges, the entire of the main soundings of the bay are clear bottoms, varying with mud and sand, and sand and shells, the depth being from nine to twenty-five fathoms to the Arran Isles. Inside the Arran Isles are many extensive patches of coral reefs, having from seven to nine fathoms soundings, over which no trawl net could work. Along both the northern and southern shores of the bay, extending along the five-fathom line, are extensive ledges of rocks, many running out to seven fathoms in the bay. Reefs and shoals are all along the entire range of shore, and which occur off Ballyvaughan and Gleninagh to Blackhead, and round to the Murrough. The entire of the northern shores present similar protection against the working of the trawls. Immediately outside of the Arran Isles, and also at the entrance of Dingle Bay, there are from thirty-five to fifty and sixty fathoms, which depths are of greater account from the high running seas that constantly occur during the prevailing winds of that coast.

2ndly. The finest class trawl boats on the Irish coast are those that hail from the port of Dublin, principally from Ringsend and Kingstown. They rate from forty to sixty and seventy tons, and are of superior equipment, to stand the heavy weather experienced, particularly in the spring months, when they work along the north-eastern ground off the Mourne reaches. To show the superiority of this class of boats, I give in detail* the fitting out of one of Mr. Good's vessels, of sixty-five tons, builder's measurement, her value complete for sea being £1000. The estimated expenses of another boat, of seventy tons, the trawler "Leinster," exceed £1100. From the superior fitment of winches, purchases, &c., these boats can be worked by three men and a boy. The Balbriggan boats used in trawling, as well as those of Dundalk Bay, average from twelve to twenty-five tons, are light in construction, and, drawing a light draft of water, can easily and with safety be worked inshore, especially as, having no winches, they haul the trawl warp in by hand; therefore, not having the purchases the large boats are fitted with, they require more men to work them. Their size, rig, and number of hands enable these small craft to work readily inshore, and to claw off if caught with a breeze and an inshore swell. It can be clearly understood by any experienced seaman that vessels drawing on an average eleven feet, and the heavy trawl gear fifty or sixty fathoms of six-inch trawl warp out, with bridles, and having a beam of forty-five feet span, spreading with a net extending to seventy and eighty feet in length, could not venture to work along the shoal soundings of the coast that I have described, as the vessel could not safely work off with a sea and swell setting on a lee shore. The little craft of Balbriggan and Dundalk, and those of Waterford Harbour, and the boats of the Claddagh that were at one time using trawl nets, could easily and with safety to their gear work over the shallow reaches and in the narrows, which would be destructive to the gear and to the boats of a larger class. In Dingle Bay the boats that work there are of too small tonnage for the heavy seas of that exposed coast, but the means of the poor fishermen will not admit their obtaining abler boats; yet they are fully sensible of the advantage, comfort, and safety, a fine class vessel would be to them.

Having now explained the superiority of a first-class trawl-boat, taking one of Mr. Good's beautiful craft as a model, I will give a slight outline of their importance in other respects.

The subject of the fisheries has engaged the attention of our earliest legislators, and they were at one time desirous to encourage that branch of industry to the greatest extent, as being of vital importance to the maritime power of a nation. And what were the results of such encouragement? Able and experienced seamen, and good pilots—qualities that are not attainable in a day when the country would be in need of such services. We have long felt the evil that so much crippled our Newfoundland fisheries, and that reduced that once great reserve for our royal and our merchant marine, and which has caused our merchant ships to be manned by motley crews of useless and dangerous seamen. Such scenes as occurred on board the "Flowery Land," the "Ponteac" of Liverpool, and other ships, would never have taken place had we our own seaman to depend on. I recollect a charge of cruelty being brought against a captain of a ship who had a mixed crew, for always in hard weather sending the Spaniards and Portugese aloft to reef. His reasons were, that if he sent his English crew aloft, the foreigners would seize the opportunity to overpower the rest and take the ship. The superiority of many of the American ships during the last war was mainly owing to their being manned by picked seamen, while our ships were served with a mixture of landsmen untrained to the guns. On the other hand, how many instances are recorded of the daring seamanship and gallantry of our seamen fishermen! During the last winter the columns of the "Times" constantly detailed the numbers of lives rescued and ships saved by the men of our English fishing smacks. Turning to our own shores, are recorded the gallant conduct of the trawl boat "Emerald Isle," that saved the crew of the "Eva;" and the pilot that brought Her Majesty's ship "Prince Consort" into safe moorings was a Dublin trawler. Look even at our Dingle fishermen since they became trawlers, the vessels they have aided. The "James Gibbs," with a cargo of 1200 tons of coals, was brought in by them; the crew of the "Christopher Columbus" was saved by them; and no later than the 21st of January last, the barque "Thomas Kellam," from St. John's, with 600 tons of timber, would inevitably have been lost had not one of the Dingle men worked out his craft to save her, and piloted her into Ventry. And are not these men to be encouraged?—our hardiest seamen and best pilots. Look at the ports of Normandy, and see the fine luggers now going to sea, especially from Dieppe, so unlike the old lumbersome boats that sailed from Calais and Boulogne. The French encourage this spirit, to make seamen; and the law compels each boat to carry a certain number of men and boys, whether they require them or not. In consequence of the number of hands they carry, the French boats use much heavier gear in proportion to their tonnage. As a leader or a tripper to the foot rope of the trawl net, they have a heavy chain across the span before the foot rope; and their herring nets, being much heavier, cause great injury to the English boats when they come in contact.

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* See Appendix.

Any legislative restrictions put upon our own trawl boats will not, as Mr. Clay, the member for Kingston-on-Hull, sensibly expressed in the debate on Mr. Fenwick's motion, be effectual:—"If the object of his honorable friend were attained, trawling would not be put a stop to; it would simply be handed over to the foreigner."

In the references that I thought necessary for the more fully explaining the main features connected with the subject, I alluded in the first part to the peculiar characters of those lines of the east and west coasts where trawling was practised, as the remarks bore immediately on the portion I have now to give, viz., on the habits and seasons of fish. As I have explained the position of the reefs and rocky grounds in the several localities, it is now necessary to give merely an outline of the spawning habits of our sea fish, as the seasons of each kind are given in detail in the Appendix.

All oviparous fish, as turbot, sole, brill, and dory, and the round fish as they are termed—cod, haddock, whiting, ling, and hake—have their peculiar seasons, but each species, with very little variation as to regular periods, on every part of the Irish coast. It is necessary for the due development of the ova after exclusion from the parent fish, that they should be deposited in such places of shelter and security from the action of the sea, and where the depth is such that the effect of light and temperature should aid in the development. Hence the general average depth is under ten fathoms, more generally about three to five fathoms, and even less, according to locality. Turbot and soles are found to spawn in soft sand and mud, where ledges of rock shelter; cod, haddock, and ling, on a rocky or corally bottom; but all these fish so place the ova, that in the recesses of reefs, or on coral beds, adhesion or secure resting may be accomplished, and where the force or action of the tide or surf may not disturb. Cod and haddock deposit their ova on very rough ground, at such depths along the line of coast as, I before said, were necessary for bringing the ova to maturity. As it is shown that these depths vary all round the coast, the rules by which the present boundary lines are framed do not afford the remedies required for the protection of the ova and fry.

In a former paper I mentioned, with regard to Galway Bay, that numbers of young or undersized turbot were taken by the spilliards of the Gleninagh men in the shoals outside of the boundary line, and that quantities of young and spawning fish were taken in Dingle Bay by the line men of Anniscaule.

Near the several reefs along the coast there are generally shallows of mud or sand, or long inlets of sand, as along the line of coast from Balbriggan to the Bay of Dundalk. To those shallows the young fish retreat, and remain until sufficiently mature and strong to seek the grounds of the parent fish. These shallows are generally from two to three fathoms, and shoaler, and where no large trawl boat could interfere, nor on those grounds that I have described as the spawning beds; for no fish deposit spawn on the clear bottom of the deep soundings of any bay or inlet. In Brandon Bay, for instance, where a line is drawn across from Brandon Point to Coosanea, shutting out from trawling an extensive range of clear sandy soundings, within the line of fourteen to ten fathoms, and where outside the boundary line to the Magharees are extensive spawning beds. I could enumerate other cases where a useful system of fishing is prohibited, but where so much injury is caused by the very people whose modes of fishing it is considered proper to protect.

I would suggest that around the entire coast of Ireland no system of trawling be permitted within the five-fathom line, which would fully protect in all localities the young of every species of ova-bearing fish. The coastguard from station to station could as readily recognise any infringement within that line of soundings as within the present boundary lines.

The serious evils complained of on the coasts of England are the unrestricted use of heavily-leaded seines with small mesh, of small craft with beam trawls, and with pole trawls that work inshore, and which are the real destroyers of spawn and fry; for in very shoal water, and in the sandy or muddy recesses of spawning beds, those little boats readily work. I am aware of the destruction caused by these shore seines, net-waders, and others of that class; for it is known to me that a seine in scarcely a fathom of water drew on shore a large number of very young turbot, and this is practised on the east coast, and also on the west.

From the voluminous evidence given in the Report of the Commissioners of Fisheries for 1836, many valuable opinions may be gleaned. I extract the following, as appearing to be most reliable:—"Cove District—Trawling has increased, and the general opinion is that it has destroyed the spawn. The quantity of fish has diminished; supply is drawn from the *inshore pole trawlers.* The fishermen have complained of trawling by small craft within the harbour at all seasons, by which large quantities of young and useless fish are destroyed which if allowed to remain until the proper season would be productive"—(Mr. J. Smith Barry). "I am informed that trawling in the bays and harbours has increased since the fishery laws have ceased, and I am of opinion that this has tended to diminish much the supply of fish. The quantity of flat fish has diminished by the practice of constant trawling, which is *most inshore.* The supply of fish is exclusively drawn from trawling"—(Sir R. Hagan). I give these merely to show the true effects of inshore trawling by small craft.

In all my experience in the working of the large-class trawl boat in the Bays of Galway, Dingle, Ballinskelligs, and Kenmare, I have never, at any season of the year, seen spawn or fry of any kind of fish taken by the trawl net, with the exception of the fry of those viviparous fish, such as sharks, dog-fish, and rays, that have their young in deep water. It would be an impossibility for those large boats to use the net over those grounds where spawn or fry exist. I distinctly aver that the large trawl boats working in Galway or Dingle Bays would not injure the fisheries of these bays; and that the boundary line (if boundary lines should exist) in Galway Bay is sufficiently and most judiciously drawn. Those who are unacquainted with zoology may deem they are destroying an immensity of young fish when they meet with the several species of dabs (*Platessa microcephala,* and *P. limanda*), the scald fish or megrim (*Psetta arnoglossa*), which are of small size, and taken in deep water ; also the little sole (*Solea lingula*), which is taken in numbers in deep water by the Brixham and Barking trawlers. It is called by them the red sole, and quantities are either thrown overboard, or found lying in the boats. Its general size is four inches. These several fish mentioned may be mistaken for undersized or fry. It is much to be regretted that the poor Claddagh men have not boats and gear equal to fish on the proper grounds, for it is not when the fish come into the shoaler water of the bay that they are in condition to take. I have seen flabby and poor fish in the markets of the Claddagh, like our "Dublin pea cod," the most unwholesome fish on sale; for no unsound or ill-fed meat in a butcher's stall could be worse than those bloated fish, irrespective of the destruction of such large masses of spawn.

In Ballinskelligs Bay, on the coast of Kerry, one of the wildest on the south-west coast, and noted for the numerous wrecks and loss of life, I have never met such materials as described by Mr. Fenwick, from the information afforded to him by the captain of a trawler, and by the North Sea man. With a vessel of eighty tons, having a trawl beam of forty-five feet span, we, in a stiff breeze and swell, towed fast across the bay. In the trawl we had eighteen cwt. of fish, the heaviest take I have ever noted. What a representation, that three tons' weight were taken by this captain of a trawler in one haul! The romancing of such men and of Mr. Crick are not to be credited. The fish taken in Ballinskelligs Bay were splendid turbot, large soles, haddock, hake, dory, and gurnards; also fine plaice. The dory (*Zeus faber*) are particularly fine in the bay. Small-sized scaldfish, which is a deep-water species, were plentiful. The fish were beautifully clean, and many of them lively when freed from the trawl net on deck—not a fin disturbed; for I particularly admired the expanded pectoral fins of the sapphirine gurnard (*Trigla hirundo*), and its vivid colours. Fine specimens of the piper and cuckoo gurnards were also taken, and the *Trigla pini* of the Mediterranean. In Kenmare Bay, haddock, sole, and plaice have been taken out of the trawl net uninjured and lively, and have been transferred to the beautiful fish ponds of Mr. Bland, of Derryquin Castle. In Kenmare I obtained in the trawl a fine specimen of *torpedo*, the *Torpedo nobiliana*, which I examined in a perfect and living state. When first trawling was commenced in Dingle Bay, the opposition by the local fishermen was equally violent as that still shown by the Claddagh. Encouragement to the Dingle men, and showing convincing proofs of the benefits of improved systems of fishing, have so influenced them, that they are all now the strongest advocates for trawling.

Sir Richard Griffith, Bart., who, as Chief Commissioner of Fisheries, presided at an inquiry held at Dingle in January, 1862, on an appeal made by the Dingle men, to rescind the boundary line, saw at once the manifest improvement among the fishermen. I submit a letter, dated the 24th of March last, which proves how beneficial Sir Richard's decision has been. This letter is from one of the most experienced and influential among the Dingle fishermen.*

In the Appendix are given the depositions of two most experienced seamen and masters of trawl boats, employed in the Bay of Dingle, as to the results of trawling, and how little injurious it has been to the fisheries of the Bay. The Dingle men at first avowed that the greatest destruction was caused to spawn, without, like the Galway men, knowing really what spawn was. The Galway men swore that they *observed the eyes of the young fish in the sponge* (*Raphyrus Griffithsii*), and the young state in the *Halichondria panicea;* like the line fisherman at Mullaghmore, in June, 1861, who swore as to *spawn* taken by the trawl, which was nothing but *Ascidia mentula* and Alcyonium. It has been suggested that the trawl net should have very large meshes. Practical men know well that, no matter how large the mesh, the elongation of the mesh in fast drifting will keep in the smallest fish. It was proved before the Royal Commission inquiring into the coast fisheries of England, in December last, that the seines used in the tidal parts of the Esk destroyed an immensity of young fish. Unfortunately the practice is still permitted, the only restriction—the mesh to be altered to the salmon size. I find it an impossibility to condense all these views, therefore I shall briefly allude to the ranges of fish and to the hook boats. So certain and regular are the movements of soles and other fish upon our coast, that each year the trawl boats have their seasons—the north-east grounds, the Isle of Man, and the south coast, off Wexford and Waterford—as the fish approach their beds to spawn, or change their feeding grounds. In Dingle Bay the changes are similar. In January the soles are in deep water off the Wild Bank and Doulas Head—in

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* "*Dingle*, *24th March*, 1864.

"SIR,—As I am aware that you have returned from London, and that you are always anxious to know the state of our fisheries, I beg to let you know that cod and ling are as plenty in our bay this season as they have been for the last ten years; but haddock is scarce, not even in our bay, but all around the western coast. I am proud to say that there is a good feeling between the hook men and the trawlers; all are fishing on the same ground, and are getting large quantities of the finest fish, and in the best condition. The canoes are getting cod and ling, and the trawlers soles, turbot, and britt. It gives me great pleasure to say that I did not hear a single word of dispute between the hook men and the trawlers this year. The trawlers do all in their power to keep from the lines; and if they chance to take away any part of them, which only happened once or twice this year, they pay the canoe men at once for the damage, so that all bad feeling is done away with. The canoe men this season, when they would get a fine day, earned from three to six shillings per day, each man. The trawlers are doing as well this year as they did for the last five years. The large boats are doing well, and I send you a return of a day's fishing of a small boat of eighteen tons.

"Sir, I hope this sufficient to let you see that there is no decrease in our fishing as yet either by the canoes or trawlers. I am sorry to tell you that many of our fishermen are doing but little, in consequence of the small open boats they have, and could not venture out in stormy weather.

"I am Sir, &c.,
(Signed) "EUGENE MORIARTY.

"*Wm. Andrews, Esq.*"

February and March, off the Ventry grounds. In April they go inshore and up the bay. After spawning they return again to the Ventry ground; and in autumn, out of the bay, retire into deep water, causing the bay to be regularly fished out; but, fortunately, the next season the same routine goes on as abundantly as ever. Just so in Galway Bay—the early season is off the Murrough. From February, March, and April, they are in the bay, when after they again retire to deep water.

Haddock, that is said to be banished by trawling, is a deep-water fish, and is still abundant on the coasts of Ireland; but, going in shoals, and being a voracious feeder, they change their feeding grounds. According to weather and seasons, they are some years frequent in the bays of the west coast. They were so abundant along the south shores of Dingle Bay, in 1861, that the Dingle canoes brought in large numbers every day. They are still abundant on the grounds north-east of the Skelligs, off Smerwick, and the North Blasket, also off Kinsale and on the Nymph Bank; but the distances are too great for the canoes and the small class hook boats to go for them.* Mr. Austen, at the meeting of the Board of Fisheries at the Custom House, in March last, made a sensible remark, that he did not consider that trawling had banished haddock from Dublin Bay, for they are plentiful on the coast of England, where trawling had been carried on for a hundred years.

I must conclude by observing that fish of all kinds are as plentiful around the coasts of Ireland as ever; but the boats of the hook or line fishermen are only fit for moderate weather and off-shore winds. The herring and the oyster fisheries would occupy very long papers; I must, however, say that I do not coincide with Mr. Mitchell's views as to the mode he describes of the spawning action of the herring. The oyster fisheries are much engaging the attention of the Commissioners and my zealous friend, Mr. Barry. There are great difficulties in settling public and private rights of the beds, hence the few applications for the formation of beds.

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* The drawings represent the points of bearings of Innisnabroe, one of the Blaskets, which form the western bounds of the outer sound of the Great Blasket. It is a safe and clear passage, having sixteen to twenty-one fathoms close in, and twenty-eight fathoms mid-channel. In the course from the southward steering east of the West Blasket, Innisvickillane, (No. 1) represents the very beautiful and singular features of the point, bearing about N. W., remarkable for the almost basaltic appearance, and the perforations caused by disintegration and the action of the sea. The singular forms assumed by this vertical Old Red Sandstone formation are strikingly beautiful, and give very peculiar characters of the Old Red Sandstone of the Dingle beds. A very valuable and able paper was some years since given by Sir Richard Griffith, Bart., at a Meeting of the Royal Geological Society of Ireland, "On the Order of Succession of the Strata of the South of Ireland"—in which he particularly refers to the Upper Silurian series of Ferriter's Cove, and the Old Red Conglomerate, which usually form the base of the Old Red Sandstone or Devonian Series.

No. 2 Drawing is taken in the course from the Tearaght Rock, the point bearing by compass S. E. by S.

The fishing grounds off the Islands particularly N. W. of the Tearaght, and N. E. of Innistooskar, are excellent, with abundance of fine cod and ling; but there are no boats in Dingle Bay equal to keep on those grounds.

Again, with reference to the Claddagh case, Mr. Anthony O'Flaherty and others had well lauded the virtues of the Claddagh, and they have spoken of their poverty, all of which we readily admit, and we feel commiseration for their melancholy hearths. Some here this evening may know of the charming walk from the Hague to the pretty village of Scheveningen; the beach that is so gaily promenaded by happy summer strangers of all nations, and all so animated amid those beautiful walks and elegant houses; but behind are concealed narrow lanes, in which a silent and poverty-stricken population are hidden. These are the brave seamen and fishermen of Scheveningen, a population characterized by all the peculiarities of the Claddagh. They are a race within themselves; poor and free, they own no masters, recognise no authority, and obey no owner. The fisherman and girl of Scheveningen are marked by characteristic honesty and virtue; they love the sea, and they love their *dunes*. Surely, then, those men who so strongly advocated the cause of the poor Claddagh race, at the meeting held in Galway on the 28th of March last—the Dalys, the O'Flahertys, Burkes, Blakes, &c., will not hesitate with approved security to aid these suffering men and their families; and I venture to affirm that the "Trustees for bettering the condition of the Poor of Ireland" will at once give attention to their application. Assistance so given is far more likely to stimulate industry than any government aid or interference,—the surest course being to arouse and direct the fishermen to work upon their own resources independent of all gratuitous relief.

I would now conclude, in reference to the Claddagh, with the words in the memorial addressed by the inhabitants of the town and county of the town of Galway to His Excellency the Earl of Bessborough, in 1846:—"Patient and hardy at sea—a labouring race, whose loyalty is proverbial, whose virtues are their own, and whose faults are in the main attributable to the want of encouragement for their trade, by which so much wealth is annually lost to Ireland."

The CHAIRMAN said, the subject of the very able paper which the Society had just heard was of the greatest importance to the community. Having borne testimony in favour of the character of the Dingle fishermen, the Chairman remarked that the question as to whether trawling was destructive to fishing grounds was an open one. If Government should issue any commission of inquiry on the point, he trusted that it would be an effective one.

Mr. GOOD, the proprietor of a large number of trawlers, addressed the meeting at some length. He said—I have listened with much pleasure and interest to Mr. Andrews's very able paper just read. I believe that the trawling community all round the coast of Great Britain and Ireland owe him a deep debt of gratitude for the manner in which he has advocated their cause, having proved by his great scientific knowledge, together with his thorough practical experience, that deep sea trawl fishing is not attended with the effects alleged by the hook and line fishermen, as well as other prejudiced and ignorant people, that is, of destroying spawn and young fish. It has been most absurdly and erroneously stated on the occasion of the Royal Commission being appointed in 1863, to inquire into the deep sea and coast fisheries of Great Britain and Ireland, that twenty tons of spawn were taken up per week by each trawl boat, whereas the fact is that three tons of fish per week in the aggregate are rather above than below the average taken by each trawler. I can also speak positively from my own personal and practical experience for the last twenty years, that I have never seen, nor heard of, the spawn of any oviparous fish being taken up by a trawl. The spawn of the different varieties of cuttles fish are frequently taken in soft mud, in the winter and spring months. I have often both seen and heard of the spawn of the common squid (called by the fishermen, scolch, or pound of candles), being mistaken for haddock spawn. The several varieties of oviparous fish are known by ascertained facts to deposit their spawn by instinct in soft, sandy patches, which are protected and sheltered from currents and other influences by rocks and rough bottoms, over which no trawl net could possibly be worked. Proofs may be cited in numbers, to show that the spawn is not injured by trawling: for example, the herrings, which spawn all along our coast, have gone on increasing in the most prodigious quantities for a number of years back, and in fact the herring fishing has never been so prosperous and productive as for the last five or six years back. It is a remarkable fact in evidence, that the very grounds upon which the herrings are taken have been trawled over continually for the last forty years or more, whereas the herrings which have frequented the Killybegs in such very large quantities from time immemorial have entirely deserted that coast for the last eight or nine years, and have not since returned, although no deep sea trawling has ever been carried on there. I may also remark, in like manner, that the haddock which were found in such abundance along the east coast of Scotland appear to have entirely deserted it, though that coast has never been trawled over; they are still taken in large numbers in the deep water of the North Sea by trawlers fishing for the London market; indeed, I may add, that eight-tenths of all the sea fish sent to London and other large English markets are taken exclusively by the trawl. The fish in the Plymouth and Brixham trawling grounds have not fallen off in supply, although trawled over constantly by 300 of the largest class of boats. I fully agree, and hold with Mr. Andrews in his opinion, that most, if not all the mischief done to spawn and young fish is caused by a small class of boats, with beam and pole trawls, and with herring, sprats, and sand-eel seines, which are constantly used at the mouths of rivers and estuaries, and the shallow parts of the bays on different parts of the coast; and I should think his suggestion of drawing a five-fathom line all round the entire coast, and wholly excluding trawling inside that limit, a very admirable one, and would be much more effective in preventing the destruction of the spawn and young fish than the enlarging of the meshes of the small trawl and seine nets, all of which could take up the smallest flat fish, no matter what size the mesh may be. The establishing of a healthy and successful system of trawling at Dingle is entirely due to the labours and exertions of Mr. Andrews, there—many of the Dingle fishermen being now proprietors of good and strong vessels, assisting largely in the supplying of the Dublin market with soles during the winter and spring months, before soles are taken on this coast; they are, as well as good fishermen, expert pilots, which is a matter of great importance on that particular part of the coast, where so many disabled vessels from America fall in, requiring assistance; and these very Dingle men who are now such advocates of trawling were as blindly opposed to it heretofore as the inhabitants of the Claddagh are at the present time, and I am really at a loss to know how the Claddagh men have found so many admirers and sympathizers with them in their blind opposition to trawling. I can well recollect the time when the Rev. Mr. Syng, of Arran, who had a trawler in the bay, was hotly persecuted by them, and had several times a narrow escape of his life. On one occasion several were arrested for their violent conduct to him, and for which they would have been severely punished but for the late Henry Grattan's kind interference on their behalf, and by their pledging themselves never again to interfere with, nor show any hostility to trawlers or trawling. This Mr. Grattan has himself told me: he was at that time after having purchased the Claddagh. I would suggest to the local Galway gentry who are interested in the Claddagh men, and anxious to improve their condition, to assist them, as Mr. Andrews recommends, in getting loans of money from the Society for bettering the Condition of the Poor of Ireland, and thereby enable them to get large boats, with long and deep trains of herring and mackerel nets, and pursue drift net fishing along the coast; and also come round to the Irish Channel in the proper season, and take share of the rich harvest which has been reaped principally for many years by the Cornish and Scotch fishermen in the herring fishery. At present, however, I am happy to state, that a large number of boats belonging to Dublin, Kingstown, Howth, and Skerries, &c., and increasing yearly, have got their full share of it, they being rather more successful even than their Cornish cousins. The English and Scotch boats rarely or never fish in any one place longer than from two to three months, but keep shifting their grounds according to the peculiar season in each place; instead of pursuing this plan, if those men acted like the Claddagh people, and remained constantly in the one bay, I am of opinion their condition would be pretty much the same, and their minds narrowed to the same compass.

Mr. **Burke** thought trawling was calculated to denude the coast of fish, and hoped that Government would interpose to restrict it within proper limits at places where it was injurious.

Mr. **Hickson**, Q. C., referred to his experience of trawling off the coast of Kerry, and particularly Dingle, and said it was the general opinion of the proprietors that it should not be permitted within the boundaries. The proper grounds for the trawlers to work on should be outside the headlands in deep water. They should not be permitted to fish inside the headlands of Bray Head, at Valentia, or within such headlands as Kerry Head, and Loop Head.

Mr. G. W. **Maunsell** observed that but for trawling fish would not be had cheaply. The objections to it were analogous to those made to the employment of machinery in weaving and other departments of industry, which, though it might injure particular interests, yet was beneficial to the whole community. The answer to a great deal of what was said against trawling was given by facts as to the migrations of fish. Previous to 1799, an immense herring fishery was carried on out of the seaports of Denmark, when suddenly in that year the fishery grounds were deserted by the fish. The fisheries were ruined, and the capital employed in them was turned into other directions; and yet, after some ten years' absence, the fish returned again to the same grounds in as great numbers as they had frequented them before.

Mr. Thos. F. Brady, Secretary to the Commissioners of Fisheries, said,—I think not only this Society, but society at large, ought to feel deeply indebted to the learned lecturer for his admirable and highly interesting paper this evening, and for the careful study he has given this most important subject. I can bear testimony to the truth of several of the statements made, having trawled in several bays in Ireland, including, Bantry, Dingle, Galway and Dublin, and have never yet seen that destruction of spawn or young fish which is attributed to trawling; and I never saw spawn taken up. The statement made that the fishermen at Dingle were working harmoniously together is particularly gratifying to me, as I was, under Sir Richard Griffith, the humble instrument of having the restriction against trawling in that bay removed, after carefully examining the bay practically for several days previously, and trawling therein; and the evidence on which that change was made was irresistible, all the fishermen of every class having had ample opportunities of giving their testimony before Sir Richard Griffith. Statements have been made that trawling is injuring the fisheries of the country; that the men and boats are dying out; but the fact is, there is more fish going into the London market now than ten years past; and the boats round the coast of Ireland, in the important fishing stations, are increasing in number, and better in class; this is evidence against the statements made. With respect to the oyster fisheries of the country, it may not be generally known that we have at present a very large export trade to England and France, of young oysters, to lay down on other beds. Off the coast of the counties of Wicklow and Wexford, there are ranges of oyster beds about twenty miles in length, and in breadth from one to three and four miles wide; and the trade in this place this year has been greater than can almost be conceived; carried on by English and French buyers, who, I am informed, on many occasions paid in Arklow alone as much as £1000 to £1200, and £1400 a week, for oysters for export; and from Wexford port alone were shipped, during the past season, no less a quantity than 25,000 tons to England and France. Few people know we have so large a trade near us. At present there are fifteen Jersey boats working on these beds; between twenty-five and thirty tons is the average weekly amount sent by the trading steamer to England, commencing in September: March, April, and May are the principal months for the export. A new bed, with very large and fine oysters, has been discovered off this coast this season. The price has greatly increased within the last four years. I have only to say, I think Mr. Andrews' papers exceedingly important and valuable, and that we should feel much indebted to him for his researches on this very important subject.

Mr. Andrews replied, saying that he could not conceive upon what grounds Mr. Burke entered into such views of the Fisheries as he had expressed. Mr. Burke appeared wholly unacquainted with any state of our Fisheries, or the best means for their promotion and protection; and with reference to Mr. Hickson's representations, he considered he was misinformed as to the opinions entertained by the proprietors. Six hours in a trawler outside Bray Head, at Valentia, or outside the bearings of Kerry and Loop Heads, would afford Mr. Hickson an ample, and not to him a very desirable, test of such fishing grounds as those to which he proposed to restrict the trawlers. He (Mr. Andrews) said that he felt extremely gratified at the manner in which his statements had been received by the Society.

A vote of thanks was proposed to him for his able communication, which was carried by acclamation, and the Society adjourned.

APPENDIX.

SPAWNING PERIODS OF FISH.

The following statement is merely in relation to those fish that are taken in the trawls, and to those that are generally sought for by the line fishermen. A future publication will embrace more fully the habits and seasons of the several kinds of sea fish that are known to frequent the coasts of Ireland.

Conger vulgaris, the conger eel—At the entrance of Dingle Bay, in deep water, congers of large size are taken by the line from April to the end of summer. The conger spawns in December and January, and the fry during the summer and autumn are frequently found among the shoal reefs of rocks in the bay. The conger destroys large numbers of the young of the lobster and crab. It is valuable as bait for the long lines.

Ammodytes tobianus, sand eel.—In great abundance on the west coast: on some parts of the coast, raking on the shingly beds for sand eels at low water affords great excitement. It is a favourite food of the turbot, and in many of the shoal sandy inlets frequented by the sand eel is the feeding ground of the young of the turbot and the brill.

Belone vulgaris, gar fish.—These fish frequent deep water; but early in summer they come into the shallow bays and inlets to spawn. They are in fine condition throughout the summer, and considerable numbers of large size can be taken in Dingle Harbour with the seine; they are excellent eating, but are only valued and taken for bait.

Morrhua vulgaris, common cod.—Is a deep water species, and only visits or approaches the shoaler grounds of the coast during the winter and spring months to spawn, where it is taken in great numbers by the line fishermen, and not unfrequently in the trawls. Its condition at that season is very inferior. The cod fish spawn on rocky and corally ground from December to February, close in with the land. The fish quickly recover from the spawning state, and retire into deep water, where they remain throughout the summer until the end of autumn. It is in the summer that they are in the best perfection for the table or for curing. The same may be applied to the haddock and the ling. Cod fish feed voraciously on molluscous animals, crustacea, and the squid, *Loligo vulgaris*, which abound in the gravelly and shelly soundings where the fish feed during the summer months. Large quantities of the prawn, *Palæmon serratus*, and *Pandalus annulicornis*, have been found in the stomach of the cod, taken in eighty fathoms.

Morrhua æglefinus, the haddock, is of exceedingly wandering habits. It spawns during the spring months, generally from January to the end of February, on the west coast, and as late as March on the east coast. It then approaches the shore, and spawns on very rough or corally ground, the average depth being about five fathoms; after spawning it retires into deep water off the coast, and feeds on coarse sandy or shelly grounds. It is throughout the summer and autumn in fine condition. Haddock not unfrequently, as they are generally in numbers together, come into soundings of ten to thirty fathoms, if the feeding grounds are good. They are then taken in large quantities both by the hand line and spilliards. At other times they altogether desert their usual haunts, probably seeking more abundant feeding grounds. On most of the deep water banks of soundings around our coast haddock are still plentiful, particularly on the ranges of the Nymph Bank. The boats on the south and west coasts are at present too small to keep the sea and to fish with lines off the coast, where the haddock and other kinds of superior round fish are to be found. Thus, for the same season, the

Brosmius vulgaris, the torsk or tusk, is rarely taken, although abundant in deep water soundings off the western coasts. It is an excellent fish, and has the habits of the cod fish. In the Feroe Islands the fishermen only occasionally take them when cod fishing, but after a gale of wind and heavy sea on shore, numbers are thrown on the beach. This proves the quantity in deep water off the islands. In eighty fathoms off the Tearaght Rock, a number in fine condition were taken in the month of July.

The best feeding grounds of the haddock are on coarse gravelly and shelly ground; and the North Sea men know at once by the soundings the proper ground to find them on. In Kenmare, when trying the soundings, we met a fine bottom of shelly gravel off Ardgroom Harbour in twenty-two fathoms. Our long lines were set, and in some hours afterwards we had a fine take of large haddock. The bait used was the *Tapes decussata*, called in Kenmare Bay, *budherees*. A number of small boats were hand-line fishing off Kilmachalouge Harbour, and got but few fish.

Merlangus vulgaris, the whiting, spawns in February and March. In the bays of St. Finian and Ballinskelligs, off the coast of Kerry, and in Galway Bay, they are very fine, and are taken in fifteen fathoms water in great number.

Merlangus carbonarius, the coal fish, is taken in considerable quantities off the Arran Isles, and are very fine and large on the south coast. They are destructive fish to the herring fry and sprats. Their condition is the best in the winter months, before they spawn in February and March.

Merlangus pollachius, the pollack, are in great numbers among the rocky ledges of the Blasket Islands; they spawn in December and January, and are in fine condition throughout the summer. This fish, with the hake,

Merlucius vulgaris, are taken in large numbers with hand lines. The hake is a valuable fish, both in the fresh and in the cured state, to the poorer classes; westward of Kinsale, and the entire range of the south-west and west coasts, the hake is abundant, and during the summer and autumn months are taken in large numbers with hand lines on the same ground the trawlers work. The hake come into the bays in large sculls in pursuit of herrings. They are very destructive to the herring; and also the blue shark, *Carcharias glaucus*, which follow the herrings. Large numbers of hake are taken in the trawl, particularly in the spring months, when they approach the shore to spawn; like the cod, ling, and haddock, the hake spawn on rough ground.

Platessa vulgaris, the plaice, is exceedingly fine in Dingle Bay, and on several parts of the west coast. Their goodness depends much upon the soundings, where the trawls work, as is the case with most of the Pleuronectidæ. Dingle plaice, during the summer months, are in the finest condition, and are equal to the plaice taken on the Diamond ground on the coast of Sussex; they are also fine at the entrance of Galway bay. On the west coast they are on the spawning grounds in February, March, and April. They spawn in shoal water on a muddy or sandy bottom, protected by ledges and reefs.

In May, and throughout the summer, they are fine, and are abundantly taken in the trawls. I have seen plaice taken on the Dublin coast, in mature spawning condition, in January. When plaice, the Mary sole, and dabs appear in numbers on the trawling grounds, the soles have generally moved into deep water, chiefly in the months of July, August, and September.

Platessa microcephala, the lemon dab, or Mary sole.

Platessa limanda, the common dab.

Zeugopterus megastomus, the whiff, are taken throughout the winter and summer months in the trawls, and are valuable to the line fishers for bait, and also for baiting the lobster pots. These several species spawn early in summer, in similar localities to the plaice, chiefly in muddy and sandy inlets.

Psetta maximus, the turbot.

P. rhombus, the brill, are very fine and abundant off the west coast. Turbot of great size are taken in large quantities by the canoes in the Blasket sounds; south of the Great Island, and on the Wild Bank, from May throughout the summer, and during the spring and summer months in the trawls. In every sandy bay, and on the sandy soundings along the entire range of the west coast, turbot are fine and abundant. They are of large size at the entrance of the Shannon, and are taken in the trawls in the month of August, on the north side of Galway bay. Turbot and brill are found in mature spawning condition in the month of April. They resort to sandy inlets to spawn, where the grounds are well protected by rocky reefs. The fry remain during the summer and following winter in very shoal water until their growth strengthens them to move into deep water; the favourite food is the *Acera bullata.*

Solea vulgaris, the sole. Soles are remarkable for their size and superior condition on the west coast. They approach the shoaler soundings of the coast to spawn during March and April, on the west coast. They are in full spawning condition on the east coast in April. Soles are in fine marketable condition previous to leaving the feeding grounds, to go into the shoal and muddy inlets to spawn. After depositing the ova, they quickly recover their condition, and move from the shoals to their feeding grounds again; during the summer and autumn they keep more in the deep water. The fry remain in shoal and sheltered inlets, where the trawl net of the large boats cannot be used.

All oviparous fish, as the turbot, soles, cod, ling, and haddock, very quickly recover their condition from the spawning state, and return to their usual feeding haunts. No systems of fishing are more injurious to the spawning resorts of the fish and the young fry than the unlimited use of shore nets, and the practice of net wading, and also the setting of spilliards in shoal water, during the spawning season.

The different species of gurnards are taken in numbers in the trawls, and by hand lines. Several of the species spawn twice in the year. In summer and autumn, the grey gurnard, *Trigla gurnardus*, and the sea bream, *Pagellus centrodontus*, sometimes give a great harvest to the small shore boats.

Zeus faber, the dory. This delicious fish is very frequently taken in the trawl, and is of large size, in Ballinskellig bay. I have seen it of ten pounds' weight. The dory is a ground-feeding fish, and spawns in early summer in three fathom water in the sandy recesses, where the ova can be protected. In the summer and autumn months it is in fine condition.

A singular fact with regard to the distribution of fish is, that the angler or frog fish, *Lophius piscatorius*, most occurs on the east coast. The angel or monk fish, *Squatina angelus*, is the more frequent on the west coast. These are ground-feeding fish of large size, very voracious, and destroy an immense quantity of young fish, particularly of flat fish. They are frequently captured by the trawl, but are rarely taken by the line.

Rays and dogfish, and also the young, are taken in numbers with trawls—among them,

Raia oxyrhyncus, the sharp nosed rays;
—— *maculata*, the white skate;
—— *clavata*, the thornback;

are very frequent in Dingle, Galway, and Kenmare Bay, and in the Shannon. The fins of the rays are delicious eating.

In this concise review I have merely alluded to the more useful and marketable fish taken by the trawls, and it is quite clear that the varied seasons of spawning should not impose restrictions on that system of fishing; for in the mature spawning state of the several kinds of fish, they invariably retreat to such shallows and soundings, where no large trawls could work, and where the ova and fry so far remain in security.

If any decision should be aimed at as to close or fence months, by placing restrictions during the spawning seasons, all modes of inshore fishing, with nets, lines, or dredges should be strictly prohibited.

It would be very desirable to prohibit all systems of trawling (except for scientific objects) from June to November. This would on most parts of the coast prevent interference with the herring fishery, and with summer and autumn hake fishing. It would also have the tendency to direct the trawling men to turn their labours to the herring fishery, and also to line fishing in deep water.

Those who are unacquainted with the fisheries, or of the states of those of the coasts of Ireland, and of the present systems of fishing, are always recommending attention to be directed to the French fisheries, and to the adoption of their modes. Now, the coast fisheries of France have been seriously injured by the unrestricted use of shore nets, seines, and ponderous drag-nets. The latter engines largely supply the Paris markets, and are the means of obtaining the red mullet, *Mullus surmuletus.* This drag net, which is of enormous dimensions, is termed the *chalut.* It is fastened between two large and strong boats, and is so destructive in its operation, that it sweeps every thing before it. By a return dated September, 1862, there were at Dunkirk sixty fishing boats using this net; eighty-four at Calais; one hundred at Boulogne; fifty-three at Tréport; twenty at St. Vallèry-sur-Somme; nineteen at Dieppe; fifteen at Port-en-Bessin, and 109 at Tronville. These are exclusively employed in supplying the Paris markets. The consumption of fish in Paris is so large that, in 1860, the octroi of the capital cleared 1,027,920 f. By the time the sea fish are disposed of at the Halles of Paris, their cost is much increased by charges of the octroi, the *écorèur*, at the fishing stations, package and conveyance, and the percentage paid to the *facteurs à la criée*, or market auctioneers.

FITTING OUT OF TRAWLER, LAUNCHED JUNE, 1862.

Extreme length, . . .	67 ft. 8 in.
Extreme breadth, . . .	16 „ 6 „
Depth in hold, ...	10 „ 0 „

Tonnage, builders' measure, 65$\frac{11}{94}$ tons; draws 11½ ft. water.

Keel of British elm; stern post and entire of frame, and deck beams, &c., of Irish oak. Outside planking:—bottom of rock elm, 2¼ in. thick; bilges, 3 in. thick; light-water mark to gunwale, of morah, 2½ in. thick; shear-streak, of African teak, 2½ in. thick; and deck of pitch pine. The entire vessel, including deck, fastened with galvanized bolts.

Two crab winches on deck for working the fishing gear, and a patent windlass for working the chain and anchor. Mast of Polish red pine, 56 ft. long, 15 in. diameter at deck, and 13 in. at trussels, 9 in. at masthead. The mast in wake of jaws of gaff is whelped with morah and African teak.

Main boom, . .	45 ft. long, and	10 in. diameter.
Main gaff, ...	30 „	7 „
Bowsprit, ...	36 „	12 „

Shrouds of 7 in. rope, and lignum vitæ dead eyes. Stay of galvanized wire rope, 5½ in. in circumference. All running rigging, white Manilla rope; lanyards of Riga hemp, tarred.

Sails, of best material :—

Mainsail, ...	260	yds of No.	0.
Large gaff topsail, .	100	,, ,,	5.
Small working ditto,	60	,, ,,	1.
Big jib, ...	100	,, ,,	5.
Second ditto, . . .	80	,, ,,	4.
Third ditto, . . .	60	,, ,,	1.
Small third ditto, .	42	,, ,,	1.
Storm ditto, . . .	26	,, ,,	0.
Working foresail, .	60	,, ,,	1.
Large foresail, . .	90	,, ,,	5.
	878 yds.		

Of full-bleached, all long flax and East Coker canvass. The cost made up, including bolt-rope, points, thimbles, &c., 2*s.* per yard.

Trawling Gear, &c.—Trawling warps, 170 fathoms of 6 in. tarred Manilla. Bridles, 36 fathoms of 5½ in. Beam-rope, 20 fathoms of 4¾ in. Two foot-ropes for trawls, 36 fathoms of 8 in. Manilla. Length of beam for trawl, 45 ft. Weight of trawl head, or iron, 3 cwt. Two trawl nets, 80 ft. long, and 45 ft. spread, weighing, when tarred, about 4 cwt. Value of trawl gear, £70.

Ground Tackle.—One rope cable of 75 fathoms, 6½ in. tarred Manilla 4 strand rope. One chain cable of ⅞ in. diameter of Admiralty test, and 70 fathoms long. Four anchors, varying in size from 1 cwt. to 4 cwt. Value of ground tackle, £50.

Ballast, exclusively of square pig iron, value £120, and exclusive of metal step of 2½ tons.

When this vessel was ready for sea, with all her necessary stores, her value would reach £1100.

Deposition of Edward Reilly, Master of the "Lord Nelson" Trawling Cutter, of Eighty Tons.

Is a native of Dublin; has been at sea more than twenty years; three years master of the "Lord Nelson;" during that time in Dingle, the Shannon, and round that coast; knows the fishing ground well; has sounded the entire Bay of Dingle, as well the parts fished as the parts that could not be fished, the ground being foul, rocky, and broken ground, where the boundary line against trawling had been drawn, including parts having 16, 18, 20, and 24 fathoms; never fished further to the east than Anniscaule River—never to Castlemaine Bay; during the winter months south and west winds generally prevail; this would prevent fishing outside the line; trawling can only be on a sandy or clear bottom; trawling up as far as Anniscaule could not injure the spawn, because fish spawn on broken ground, where the trawl could not work; never saw spawn taken up by the trawl; if it had occurred in any quantity, must have seen it; the fishery had increased since trawling began; trawling could not injure the herring fishing, as the trawl is only in those bays worked by day; could not trawl only by day, so as to see the headlands, to be enabled to avoid rocks and shoals in the bay; could not trawl far to the westward, on account of deep water of the west coast, and heavy seas, and only in moderate weather; with southerly or westerly winds could not work the boats outside the bay; has been frequently ten days in it without getting out; has been on Dingle twenty years; since in a coasting vessel; knows Captain Sterne, Inspecting Commander of the Coast Guard; never saw him in a boat at any time; Captain Sterne sent to me with regard to the boundary line; my opinion was, that it would not interfere much with [meaning] my boat of 80 tons, but it has since been found materially to interfere with the fishing of the smaller boats; the summer fishing is the best up the bay; never at any time saw the fry of fish taken.

DEPOSITION OF PATRICK TUITE, MASTER OF THE TRAWLING CUTTER "DRUID," OF FORTY-FOUR TONS.

Is a native of Kingstown; has been at sea eighteen years,—nearly all that time engaged in fishing; knows Dingle Bay, has been there three years; has examined the soundings in the bay almost every day whilst fishing; knows the parts that can be fished with trawl nets, and the parts that cannot, by reason of the ground being foul and rocky; from his examination and experience considers that fish can only spawn in rocky places where there are small, sandy bottoms—they are thus protected from the sweep of the tide; trawls could not work in those places; never took up spawn upon the sandy bottoms, where the trawls can work; if it was there, must have seen it; always prefers a pure sandy bank for fishing on, or else the edge of a bank of mud and sand; it would not be possible, for these reasons, and considering the mode in which the boats work, to injure or destroy spawn; trawling has not injured the spilliard fishing, or long line fishing; on the contrary, line fishing has much increased, and more successful; the fishermen generally fish in shoal water, and on rough or corally ground; the boundary line has seriously injured trawling in the bay; during the winter months the trawl boats could not stand out to the mouth of the bay with the prevailing south-west winds; knows Captain Sterne and the Coast Guard; never saw them in the bay; shutting up the bay has injured the fishing, and has not increased the spawning; the round fish crowd on the grounds to feed where the trawl has worked, and the line fishermen have their best takes of fish on the same ground; when they first commenced trawling, would sometimes take twenty, thirty, or forty hake in a haul; they have since increased to 300 in a haul; trawling cannot injure the herring fishing, for when the hake are plentiful, herrings are always in abundance; the Dingle fishermen have only the means of fishing for herrings in bays and inlets, but never in deep water; the refuse fish, thrown away by the trawls, are used by the line men for bait, and in winter they can obtain bait in no other way for their long lines; there are very few fishermen in Anniscaule—they only go out of an odd day—they are badly found in boats and gear; the trawlers are very cautious in running foul of the fishermen's lines, as it would delay the boat; if they do damage to the lines, it is owing to their not being properly buoyed; the damaged lines are always paid for.

[*The preceding paper is illustrated by Plates II., III., IV.*]

II.—FURTHER NOTES ON SALMONIDÆ. By WM. ANDREWS, M. R. I. A.

[Read before the Natural History Society of Dublin, January 15, 1863.]

MR. ANDREWS said that the first paper that appeared on the list for the evening was his "Further Notes on the Salmonidæ." Urgent business matters had prevented him from completing the preparation of the extensive series of specimens illustrative of the several stages of growth of that Family which he had obtained; and he therefore had intended to defer his remarks until the next evening meeting of the Society, but finding, late in the day, that Mr. Blyth had been invited to attend the meeting, he thought it only due to that gentleman to be present, and to offer some concise observations, especially as he found that the Rev. Samuel Haughton could not attend, whose name had likewise been announced for a paper on this evening.

It is now some years since that Mr. Blyth's name was familiar to him (the President), as a gentleman well conversant with the literature of zoology, and a scientific observer of facts. His long career in India has established that reputation, by the extensive amount of practical investigations in all branches of the natural sciences that he has accomplished. It had always been forcibly impressed upon him (the President) that, no matter how well grounded in such sciences theoretically, no useful nor definite results can be arrived at without being combined with thorough practical acquirements.

The President then made some remarks on the peculiarities of the young state of the Salmonidæ, and exhibited specimens of the Parr, or Gravelling—such as figured and described in the first edition of "Yarrell's British Fishes." These fish were taken in a clear stream in the month of December, 1862, and exhibited the states of ova and of milt. They are species of river-trout, peculiar to swift-running and clear streams, and in their markings and bright silvery appearance differing from the usual varied forms of river-trout. They are also different in the character of their fins—more so in that of the caudal fin—which are strikingly seen in the forms shown in the true Salmon fry. Differences can also be seen in the form of the head and of the gill-cover.

Specimens of the young of the *Salmo salar*, and the sea-trout, *Salmo trutta*, were shown, and marked differences were observable. These several species were obtained at the same season.

The President then alluded to the large number of Sunfish or Basking Shark, *Selachus maximus*, that had been seen off the south coast of Ireland during the early part of the month of May of the past year. These valuable fish—valuable for the large quantity of pure oil that the liver of a single fish yields, averaging 120 gallons, and which is so usefully employed in several kinds of manufactures—appear on our coasts, from Boffin, in Mayo, and south to the coast of Cork, during the latter part of April and the early part of May; and at one time on the coast of Mayo and Galway an extensive fishery was carried on. Now, the fisheries of the country have so deteriorated from want of suitable boats for keeping the sea, that that fishery has been given up, and the deep-sea fisheries are altogether neglected. Mr. Thomas Alexander Montgomery, who has embarked largely in the herring and mackerel fishery, by working with boats well fitted out for our coasts, states that a large fish was brought into Kinsale in the week previous to the 19th of May, being captured in the herring nets, in which on a calm night the fish became entangled. About 150 fathoms of rope and nets were wound round its body—the nets, consequently, being much damaged. The fish was about thirty feet in length, and was estimated to weigh about seven tons, the liver about fifteen cwt. It yielded 136 gallons of remarkably fine oil, which was sold at three shillings per gallon. From the description given, this was the *Selachus maximus*. Much larger fish were seen.

The President then referred to several extremely rare Birds that had been recorded as visitants to Ireland, among them the Membranaceous Duck, *Malacorhynchus membranaceus*, which had some years since been shot in Castlemaine Bay, county of Kerry, out of a flock of six; and the *Puffinus obscurus*, obtained at Valentia; both Australian birds. A beautiful and accurate drawing of the duck, made by Mr. Du Noyer, was exhibited. He (the President) then alluded to the remarks that had been made relative to the spotted pigeon, five having been shot out of a large flock, on the cliffs of Sybil Head, county of Kerry. A case of the birds, with those of *Columba livia*, was exhibited. These varieties were merely shown, as opinions had formerly been propounded by Mr. Blyth and by Mr. Strickland relative to their identity or non-identity with *C. intermedia* of India, and as a variety of *C. livia*, under the name of *C. affinis*. The spotted pigeon of Sybil Head was far removed from any dove-cot, and was of superior size, yet not of the compact robust form of *C. livia* of the cliffs of the coast. The birds were mature, having eggs fully formed. The absence of the barred wings, with the grey rump, showed some differenee from *C. livia*; at the same time, no real specific differences could be traceable.

Mr. Blyth, late of Calcutta, addressed the meeting at considerable length on various topics, touched upon by the President in his remarks. He offered some observations on the geographical distribution of the Salmonidæ. There were peculiar forms of Salmonidæ both in the Nile and in the great rivers of South America; but there was no fish of the kind in any part of Asia southward of the Himalaya, although certain Cyprinidæ were very trout-like, even to the speckling, and were designated as trout by anglers in India; in no instance, however, did those trout-like Cyprinidæ possess the small adipose posterior dorsal fin, as in the Salmonidæ, most of the Siluridæ, and also the Scopelidæ. As a rule, where northern forms of Salmonidæ, as *Salmo Corregonus*, &c., inhabit the waters, grouse and ptarmigan inhabit the land; but there was no grouse nor ptarmigan in the Himalaya, and the nearest-known salmonious fish was a small trout in the Oxus, which river flows into Lake Aral. The lakes of Thibet are inhabited by peculiar species of barbel. Our British grey partridge, moreover (with, of course, its two Oriental congeners), was anatomically more akin to the ptarmigan than to other partridges, as had been proved by his friend Dr. Parker; and the geographical distribution of the particular form was in accordance with its special affinities. Salmonidæ, it was remarked by Mr. Blyth, barely reach southward to the north of China; and he remembered only one species the range of which extended to the northern portion of the Japanese archipelago.

With regard to the Australian Duck, *Malacorhynchus membranaceus*, he observed that its occurrence in this part of the world was most remarkable, especially as there was really no reason to suppose that it had escaped from captivity, as in instances of the black swan having been shot, or the pretty little grass paroquet, *Melopsittacus undulatus*, which had lately been imported alive in such enormous numbers. It was one of a flock of six, and it did not exhibit the slightest trace of having ever been in confinement; besides, the species had never yet been imported into Europe, and the plumage of the individual obtained was that of an unsoiled wild bird. Wilson's stormy petrel was a well-known Australian species, as well as a North American species, which is likewise of rare occurrence in the British seas; and another Australian petrel had lately been added to the list of stragglers from other regions, which have found their way into this country. In Mr. Gould's introduction to his magnificent work, "The Birds of Australia," a case is recorded of the great spiny-tailed swift of Australia having been procured "in the flesh" in England; but Mr. Blyth did not think much of the occasional occurrence of that bird, because it is common both in the Himalaya and in China. He was quite aware that distinctive differences of the most trivial kind had been suggested; but he happened to know that those supposed differences are not constant, but individual merely, and that precisely the same small differences of coloration occur in different individuals of the large spiny-tailed swift of Southern India and Ceylon, and of the Malay countries—*Acanthylis giganteus.* A small Australian Ring-plover (*Charadrius nigrifrons*) had been once known to occur in the Indian peninsula; and many of the Australian wading-birds occur more or less commonly in China. A very fine specimen of *Catarracta pomarina,* in full mature plumage, had been obtained near Moulmein, in one of the Tenesserim provinces of British Burmah, and it was exceedingly rare to obtain that northern bird in its adult plumage even in the latitude of the British Islands. Mr. Blyth had himself procured the *Phalaropus fulicarius* at Calcutta; and his friend Dr. T. Stewart had obtained the *Lobipes hyperboreus* near Madras. How many North American birds, even land birds, had contrived to find their way across the Atlantic to Ireland, especially, as might be supposed from its comparative geographical proximity! In Amesbury Park, in Wiltshire, there had actually been shot the golden-winged woodpecker of the United States, *Colaptes auratus ;* and, at all events, he had never heard of a woodpecker being imported in a cage. Such instances continue to accumulate as critical observation extends; but it seems a little absurd to add all such chance-comers to the list of what properly constitutes the British Fauna.

With regard to the spotted pigeon, to specimens of which the attention of the meeting had been directed by the President, and which Mr. Blyth remarked that he had himself been the first to distinguish as a particular race, occurring in the south of England, by the name *Columba affinis* (as noticed in the "Proceedings" of this Society March 6th, 1863),* he stated that he had now been long aware that it was no other than the common dove-cot race, which was bred in multitudes to be turned out at pigeon matches, which accounted for the great number of shot birds of this particular variety of *C. livia* which are commonly exposed for sale in the London markets. There are many local races, sub-species, or, perhaps, "incipient species," in the language of Mr. Darwin, each of which occupies its own area upon the earth's surface, or rather he would say that portion of the northern hemisphere in which the greater part of the major continent is situate. There is a *C. turretum*

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* "Proceedings of the Natural History Society of Dublin," vol. iv. (Part I.), p. 42.

(so called) in Italy, and a *C. intermedia* in India and the Indo-Chinese countries, the common blue pigeon of that region, which barely differs from the European *C. livia*, except in constantly wanting the white above the tail. He had watched great flocks of these birds, as especially those crowding about the many suitable nooks of the great mosque of Aurungzebe, at Benares, looking down upon them from the top of one of the two famous lofty minarets of that edifice, and had observed in them no variation of colour; but this race particularly frequents large buildings, equally with rocky precipices, whether inland or by the seaside, as also old ruinous walls; and in parts of the country where such do not occur, it breeds abundantly far down the shafts of deep wells; and in towns and villages it merges insensibly into domesticity, and among the more or less domesticated individuals are very many that exhibit the spotted wing of (so-called) *C. affinis*. He would, moreover, remark that among the domestic pigeons of India it is as rare to see the white rump as is the reverse in Europe. In Middle Asia another cognate race exists in the *C. rupestris* of Pallas, which occurs in Thibet, and in the British province of Kemaon. High upon the Himalaya there is the *C. leuconota*, which is another true rock-pigeon, though differing more from the rest in plumage; and in Abyssinia, again, there is a peculiar corresponding race of blue pigeon, which is denominated *C. Schimperi;* as in Senegal there is even another, denominated *C. gymnocyclos*, by Mr. G. R. Gray. The decided use of applying names to such distinguishable geographical races was, that each of them could thus be severally and definitively referred to by its special designation. This was a practical advantage, wholly irrespective of the zoological or botanical value to be attached to such appellation, about which there would, of course, be difference of opinion.

He (Mr. Blyth) then discussed the subject of hybridity, with particular reference to instances which he cited of the existence of prolific hybrids in various classes, both animal and vegetable. The whole of the races of pigeons above mentioned, Mr. Blyth fully believed, would intermingle in domesticity, and produce completely fertile hybrids, or, should he not rather call them sub-hybrids? and such races had also been designated con-species. It was so in other classes, whether of plants or animals, of which the speaker cited a variety of instances; and he descanted upon the impossibility of rigorously defining species in a multitude of familiar cases. But it was needless for him to expound in detail the views held on this subject by his friend Mr. Charles Darwin, and the large and increasing body of naturalists of superior qualifications who participate in his opinions.

III.—ON THE DEATH OF THE LION AND OSTRICH IN THE ROYAL ZOOLOGICAL GARDENS OF DUBLIN. By the Rev. SAMUEL HAUGHTON, M.D., F.R.S., Member of Council of the Royal Zoological Society of Ireland.

[Read before the Natural History Society of Dublin, February 5, 1864.]

THE great interest felt by all lovers of animals in Dublin in the untimely fate of the well-known Lion and Ostrich of our Gardens, induces me to lay the following particulars respecting their death before the Natural History Society of Dublin.

I may state, *in limine*, that my opinion is, that they both died in consequence of the continued frost of three days, followed by cold damp weather, which visited our city at the commencement of January last. It has frequently been remarked by Dr. Connor, and others well acquainted with the fate of foreign animals landed in England, that when they die of the effects of climate, the animals that in their native state enjoy the same sort of climate all die at the same time. In the dry continental climate of Morocco and southern Africa, the lion and ostrich are often called on to endure a greater degree of cold at night than that which proved fatal to our ostrich here, viz. 17 deg. Fahrenheit; but they are never subjected to that cold accompanied with damp air, saturated with moisture, and continued for three nights in succession; for during the daytime, in their own country, they enjoy the bright warm sunshine; and the frost at night may be regarded rather as a healthful stimulant than as a destructive influence.

I saw the miserable ostrich on the third day of the frost with wings drooping, and neck purple with cold, crouching close up to the little stove provided to warm the house in which he slept, and he looked literally "perished with cold." He never regained his appetite, which he lost during the frost, and died some time afterwards. On examination he proved to be enormously fat, upwards of 46 lbs. of solid fat, five inches in thickness, having been removed from the chest and abdomen. The muscles ordinarily used in walking on level ground were healthy, and in good condition; but the smaller muscles, used to balance the action of the legs on rough ground, had undergone fatty degeneration, as appeared from their examination under the microscope by Dr. Bennett. The heart was healthy, and had not undergone any degeneration. To keep such an animal in health would require the use of a large paddock, such as that in which Lord Derby used to trot his ostriches; and this, again, would require a pecuniary outlay which, I regret to say, the citizens of Dublin do not seem disposed to make on their Zoological Gardens.

The lion died of fever, and his chance of recovery was destroyed by the occurrence of the three days' frost during his illness. We had no means of protecting him from the cold, and from the still more deadly damp that followed it during the thaw; and notwithstanding that he rallied for one day, under the influence of stimulants, he ultimately succumbed to the disease, and died with all the symptoms of a human being in fever. He was a resident in our Zoological Gardens for nine years, during which time he begat £500 worth of young lions and lionesses. One of his wives was said to have been starved to death by ill-timed economy, but this was a mistake. The old fellow nearly paid the cost of himself and of his lionesses by the proceeds of the sale of his offspring; and in the very week of his death, the Society received £175 for his last brood of lion kittens. I have taken the following details of the illness and death of this favourite of the Dublin public from the records of the Society:—

"*Royal Zoological Gardens, Tuesday, Jan.* 12, 1864.

"SIR—According to the instructions received from the council in regard to the treatment of the lion, I beg to submit the following statement for their information:—On Sunday, the 27th December last, Head-keeper Rice reported to me that he did not consider the lion in good health. The following day (Monday), he appeared to be in the same condition, when hot goat's flesh was given him, which he declined. During the week he received pigeons, chickens, fresh beef, hot blood, and rabbits; but all attempts to make him eat proved fruitless. On the 7th inst. Professor Haughton, accompanied by Dr. Foot, visited the Gardens and held a consultation with Mr. Montgomery on the treatment of the lion. They agreed that it was absolutely necessary that a dose of whiskey punch should be administered to him, which was accordingly done in their presence. On Saturday last, at twelve, noon, a dose composed of two glasses of whiskey with hot water was again offered to him, in consequence of the short time allowed to prepare the broth (as directed by council). At three P. M. the broth-punch was given him, and continued every three hours to three A. M. on Sunday; but after every effort to make him take the broth-punch, he refused it. At six A. M. he partook of a very small quantity, in fact, I may say, scarcely any. At nine A. M., when Rice and myself administered the dose, he turned his head away; and, judging from the heavy breathings of the poor animal, I discontinued the dose until I should receive further instructions from some member of council. A dose was given him at five P. M. on Sunday, in presence of Dr. Foot and Mr. Montgomery, but he partook of only a very small quantity. Keeper Rice and myself sat up again on Sunday night, and visited him frequently, in the event that he died, so as to prevent the rats from destroying his skin. On Monday, 11th instant, the lion appeared to be fast declining. Professor Haughton visited the Gardens at three P. M., and pronounced him to be dying; his breathing was 33 per minute. At twelve P. M. I visited him, and found him groaning, and rapidly approaching his end. I then retired to rest, and was apprised by Keeper Rice of his death at about five o'clock on Tuesday morning. His position at death was reclining against the rails of his den, with his tongue between his teeth. Trusting, Sir, the Council will deem my report satisfactory, I am, Sir, your obedient servant,

"WILLIAM BATHO,
"Superintendent Royal Zoological Gardens.

"*R. J. Montgomery, Esq.*"

"*Zoological Gardens, Sunday, one* P. M.,
"*January* 10, 1864.

"MY DEAR MONTGOMERY—I have seen the lion, and heard Mr. Batho's report of him. He got the broth and whiskey, as ordered, every three hours up to three o'clock in the morning, when he refused to allow it to be given. I would not, therefore press him to take more, unless Dr. Templeton thinks he ought to get it at night. His respiration is 47 per minute, and very laboured, and has become worse since he refused the broth-punch.—Yours faithfully,

"SAMUEL HAUGHTON.

"*To Robert J. Montgomery, Esq.*"

"*Sunday, three* P. M.

"I approve of the above suggestions; have recommended his being tried at intervals, but not to plague him by useless attempts; to be watched closely, so that he be not left without water up to the last.

"R. TEMPLETON, *Deputy-Inspector-General, M.C.*"

The *post-mortem* examination confirmed the opinion formed of the lion's illness during his life, and furnished, by the discovery of rheumatic arthritis of long standing of the right shoulder joint, additional proof of the injurious effects of our damp climate, combined with want of exercise and of sunlight. The lion was in good condition, in fact, rather too fat; and the only anatomical trace left behind by the fatal disease that destroyed his life was a small circumscribed patch of consolidation in the right lung.

Since the visit of the Channel Fleet last summer, Dublin has been pronounced by good judges to be the shabbiest city in Europe; and the lion and the ostrich who have now left their bones with us may complain as justly as the officers and men of the Fleet of the want of public spirit in our city, which suffers our fine Zoological Gardens to languish for want of funds. Enthusiastic members of the Zoological Society have often claimed for themselves the possession of great public spirit, in opening the Gardens on Sunday, at the rate of one penny, to the public at large; but the truth is, that our Gardens would long ago have been closed, if it had not been for the aid afforded by the people's pence, which furnish one of the most important items in the income of the Society. The Zoological Gardens of Dublin are the property of the poor, rather than of the rich, who seldom visit them, except to listen to the music of a military band, and to stare at a Viceroy. If the wealthy men of Dublin really care for the innocent enjoyments of the people, let them generously replace the lion and ostrich we have unfortunately lost, and enable the Council of the Society to provide more comforts in the way of warmth and exercise for the animals imprisoned for our advantage and instruction.*

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* All readers of good taste will excuse me for adding here, in the form of a note, an *Elegy on the Death of our Lion*, that was published, shortly after the reading of my paper

In the course of a conversation subsequent to the foregoing paper, Professor Haughton stated that after a long voyage, especially from the Tropics, on reaching the currents of air from the land of high latitudes, such as our own, or, as sailors express it, on coming into soundings, it is usual for invalids and wounded men to become worse, so as often to die within a few days of landing. He believed the same influence of the land air from the English coast fully accounted for the great mortality among the animals landed in Liverpool; and it had frequently been remarked to be simultaneous among those from the same locality, as if the mortality depended on the change, almost abrupt, from their native air to the climate of Liverpool.

Mr. Blyth, in regard to the contrast which animals undergo on rapidly arriving from a tropical clime to that of Liverpool, stated, as his opinion, that the contrast was nothing like what it is supposed to be by gentlemen who had never had personal experience of the change. Animals arrived at Liverpool after a long voyage in perfect health, and, as a general rule, were not killed by the climate of the British Islands, but in consequence of the great care that was taken to prevent their inhalation of a breath of fresh air. He had himself seen but a few weeks since, at a dealer's place in Liverpool, as many as eighteen newly-imported African monkeys shut up together in a cage of very moderate dimensions, with actually a glass front, and this inside of a closed apartment. How could it be otherwise than that, under

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in the "Dublin Evening Mail." Its author does not require any introduction to the reader beyond the intrinsic merit of his verses:—

"Alas! another heavy blow
Has added to the weight of woe
Already pressing on the Zo-
-ological Society.

"'Tis only one short month ago
(A fever 'twas that laid him low),
Death took the Lion of the Zo-
-ological Society.

"The keeper found him very low,
And sent a messenger for Pro-
fessor Haughton, of the Zo-
-ological Society.

"The Doctor came, with *Foot* not slow:
He found his patient but so-so,
And told the Council of the Zo-
-ological Society.

"He wrote a grand prescription, though:
'R. Kinahan's spir: oz: duo;
Aquæ oz: sex, sumat Leo—
S. H., Physician to the Zo-
-ological Society.'

"They tried to make him drink; but no
Teetotaller was ever so
Staunch as the Lion of the Zo-
-ological Society.

"In vain they sought to urge the no-
-ble beast; that 'tumbler' was no 'go:'
He thought that whiskey-punch was 'low'
For him, the Lion of the Zo-
-ological Society.

"They watched his every dying throe;
They rubbed him down from top to toe;
So died the Lion of the Zo-
-ological Society.

"Some said it was the frost and snow;
Others declared they did not know;
But all agreed that, high or low,
Than this there ne'er was finer show
This feast of reason, and this flow
Of whiskey-punch, so promptly pro-
-vided by order of the Zo-
-ological Society."

such circumstances, the poor creatures should contract lung disorder, so many of them breathing together the same vitiated atmosphere? And he had also lately seen, both in the Botanical Garden at Oxford, and at Warwick Castle, sundry Indian monkeys which enjoy the open air in a spacious cage, at all seasons, having merely a box to retire into when they please. These were healthy, because they could keep their blood in circulation by exercise, and breathe fresh air. After all, people knew but little of the ways and habits, and of the diversified personal characters of monkeys, who had only seen them cooped up in cages, or with a chain round the loins, the animal having a pole to run up, with a box at the top of it. What should we know of common dogs or cats, if we had only seen them boxed up in cages? The healthiest and longest-lived monkeys commonly seen in these islands are the little Cebi, or "ring-tails," from intertropical South America, which are made to perform in the streets at all seasons! Among other considerations, the latter do not suffer from *ennui*, which caged monkeys often do very much. Most persons considerably underrate the intelligence of the lower animals, indeed of the more highly organized generally. How would any of us like to be shut up in a small cage, and be everlastingly teased by somebody or other, stirred up occasionally with a pole, &c.? Would our temper thereby be improved? Should not we also be apt to become sullen and ferocious? And then, perhaps, we too might have a notice put up above us—"Beware!—this animal is dangerous!" Think of the treatment of human lunatics in former days, and in some countries, unhappily, still, and of the results of modern kinder and more considerate management. Mr. Blyth was a strenuous advocate for ventilation, and a plentiful supply of oxygen, the want of a sufficiency of which, in his opinion, kills many more of the animals imported into these countries than either the chill or the humidity of the climate. Go where you will, much evil was currently ascribed to climatial causes, for which the latter were very partially, even if at all, really and actually to blame.—Mr. Blyth thought that the same remarks, a little varied, applied in a great measure to plants, not a few of which suffer considerably from the overmuch heat and humidity of hothouses, that same high temperature and superabundant moisture too being continued at all seasons to plants brought from regions where the extreme dryness of one season contrasted with the exceeding humidity of another portion of the year, while a "cold season," with considerable depression of temperature, also alternated. The well-known history of the now common *Aucuba Japonica* was instructive in this matter—a Japanese plant, from a temperate climate, first grown in hothouses, then transferred to greenhouses, where it succeeded better, then to sheltered spots outside; and, finally, as we now see it, one of the hardiest of our shrubs everywhere. Plants were alike regarded as Himalayan, whether from a lofty altitude, or from the warm valleys at the base of the mountains, and were sometimes treated in like manner. Mr. Blyth had been several times shown the Himalayan Phœnix or date palm. In the Garden of the London Zoological Society he had seen a healthy Dracæna growing in the open air in the months of January and February, which was merely sheltered a little during frost. A small Chinese palm, the *Chamærops Fortuni*, had thriven for several years past in the open ground at Kew; and in the new palmhouse at Kew, where the plants were merely sheltered from the weather outside, and that grand conservatory only moderately heated during frost, he remarked some of his old Indian acquaintances in the plant line doing much better than he had observed previously anywhere in the British Islands. As one instance, he would mention the *Plumbago Capensis*. In some instances, Mr. Blyth had observed small mango trees in pots, in hothouses, which blossomed regularly, but did not set their fruit. The reason to him was obvious. The mango requires an arid atmosphere when in bloom. In Bengal, a shower of rain, or even a mist, will generally diminish or upset the mango crop for the season. Remove the plant to a moderately warm house, with a dry atmosphere, and it will set its fruit as surely as it perfects its flowers.

Dr. Moore did not consider that the presumed acclimatization of plants was feasible. He would instance the case of the potato. This plant had been cultivated with all care, and had been propagated from seed and by division, yet was as tender—nay, more tender than when it was brought a century ago from Peru; to this day it will not stand frost. Mr. Blyth seemed to forget our very changeable climate, enormous fluctuations and alternations in temperature taking place within a very few hours; this, as well as our humid atmosphere and the comparatively little light, were circumstances which Mr. Blyth seemed disposed to overlook. The Aucuba and Palm mentioned by him were hardly cases in point—both Japanese plants, they had to withstand frost in their native country.

IV.—ON IRISH VESPIDÆ. By RICHARD L. EDGEWORTH.

[Read before the Natural History Society of Dublin, March 4, 1864.]

THE following paper on the Irish Vespidæ I wrote at Dr. Perceval Wright's request, intending that it should appear in the "Annals of Natural History;" but, being asked to contribute a paper to this Society, I thought it advisable to add my mite to the interest of our meetings, and at once accorded to the wishes of your Secretary.

The subject which I have the honour to bring before the notice of the Society this evening is one of peculiar interest, both because we possess no memoir of the Irish Vespidæ, and because the internal economy of the Vespidæ, as of all the higher Hymenoptera, cannot but command our unqualified admiration.

Of the seven species of British Wasps described by Mr. Smith, we possess only five—three ground Wasps, the *Vespa vulgaris* (Linn.), *Vespa Germanica* (Fabr.), *Vespa rufa* (Linn.), and two tree Wasps, the *Vespa Britannica* (Leach), and *Vespa holsatica* (Fabr.), (= *V. Sylvestris*, Scop.).

The *Vespa borealis*—a species originally discovered by Mr. Smith— —and the *Vespa Crabro* (Linn.), as far as I am aware, have not been yet noticed in Ireland.

Before I proceed to the consideration of the details of each species, it is necessary to allude to the estimate of Wasps in a populous community, originally made by Reaumur, and since repeated by many naturalists. Reaumur assumed that there were 10,000 cells, and that each and all produced during the season three Wasps, thus producing 30,000 Wasps. That Reaumur's calculation is erroneous is proved by the fact that 30,000 Wasps could not be contained in any average nest. For, assuming, according to Mr. Smith, that each Wasp is in length seven lines, and in depth and breadth respectively two lines, the space which each Wasp must occupy will be 0·0162 of a cubic inch; therefore, 30,000 Wasps will almost occupy the entire contents of a sphere whose diameter is ten inches. Now, a nest of such dimensions as this is seldom to be met with in these countries. I have therefore shown that the 30,000 Wasps which Reaumur postulates would occupy the solid contents of the largest known nest; but two-thirds of each nest is occupied with cells; therefore in a nest of ten inches in diameter there could not be more than 10,000 Wasps in the closest possible juxtaposition. Now, it is reasonable to suppose that each Wasp requires at least three times his own space; therefore, even a nest of ten inches in diameter could not contain more than 3000 Wasps.

Again, I shall show that those phenomena are not presented which we should expect from the presence of 30,000 Wasps. I find by observation that each Wasp occupies about twenty minutes in each journey, and remains about twenty minutes in the nest after he has come in, and therefore each Wasp passes the entrance of the nest three times an hour; therefore the number of Wasps in any nest is a third of the sum of exits and entrances observed in an hour; or, conversely, the sum of exits and entrances is three times the number of Wasps. Accordingly, in a nest of 30,000, the number of exits and entrances would be 90,000 per hour, or 1500 per minute, and such a nest, I believe, has not yet been observed. I should also add that I have seldom seen a nest which contained 2000 wasps. Mr. Smith has seen one with 2590; but it is very possible that climate may affect the size of Wasps' nests very considerably.

The nests of Wasps vary in size very much, according to the favourableness of the weather. In dry seasons they are generally larger. The mildness of April and May, not so much as the number of queens seen in the spring, or the quantity of nests the preceding year, seems to affect the number of nests for the present year. Wasps are very delicate animals, and peculiarly subject to the influence of the weather; but the severity and wet of winter itself do not appear to affect their number the following summer. It is impossible, at least from such circumstances, to predict the number or the paucity of Wasps. Such, at least, is my experience, confirmed by carefully comparing the various notices in the "Zoologist," which form valuable statistics on this point. In

1848 the total number of queen Wasps captured was the almost incredible amount of 14,750, weighing sixty-three ounces. It is to be regretted that the various species of Wasps to which these belonged were not determined. It is most probable that few of them, or at least comparatively few, were *V. vulgaris*—in reality the only formidable species, as that species has few queens, both in proportion to its nest and its crowd of workers.

Vespa Germanica seems to be almost a variety of *V. vulgaris*; at any rate, the habits of the two are so similar, that one description will answer for both. *Vespa vulgaris* is the common Wasp of Ireland; but in the county of Down, Mr. Haliday assures me that *V. rufa* is more common.

I give no description of this or any other Wasp, as Mr. Smith has completely exhausted the subject; but it is worth while remarking that the colour and size of this insect seem to depend very much upon the locality in which its nest is situated. I have observed that nests which face the sun generally produce small, bright yellow, very active Wasps; whereas the Wasps from nests in dark and shady places appear larger, darker, and lazier. The same phenomenon is to be seen among Ants—some being lighter, and some darker than others, without any other very apparent cause than that suggested by the situation of their nest. It has also been remarked that each individual Wasp, as he grows older, alters considerably in size and colour.

Locality selected for Building.—The situation in which each Wasp builds is generally very characteristic of the species, and therefore it is a matter of some importance to endeavour to ascertain the usual locality selected by each different Wasp. The nests of *V. vulgaris* are generally formed in dry banks, in the roots of decayed trees, and occasionally in the thatch of cottages, or other similar places, but may almost occur anywhere. Mr. Smith says he has seen one in a pump. In the "Transactions of the Ashmolean Society" (xx. 3), a nest was found in a loaf of sugar, the shell being partly composed of the surrounding thin paper. I have seen nests in a turfstack, under a window-sill, and in the bottom of a barrel of brown sugar. All the larger nests are to be found in dry sunny spots; but the Wasps always seem to like water near them; they also generally build near houses, or at least in cultivated places, and I have seldom found a nest in any exposed situation. It is also a most singular and remarkable fact, which I do not remember having seen noticed, that *Vespa vulgaris* invariably builds beside the nest of a wild bee, either *Bombus terrestris* or *B. agrestis*. In about 90 per cent. of nests I find this to be the case, and the only exceptions to this rule seem to be those nests situated in such anomalous positions as pumps and sugar loaves. It is often, however, very difficult to find the nest of the wild bee, which frequently consists of only a dozen individuals. On examining the combs of these wild bees, there does not seem to me less honey than there ought to be, though the Wasps may be often seen going in and out familiarly.

Wasps, if possible, choose a sloping place in which to build, so that the earth they have been mining may easily roll out of the hole; so much so, that at the entrance of their nest a quantity of loose earth is generally to be seen, as if a mouse had been burrowing. Sometimes *V. vulgaris* builds under the thick tapestry of moss that drapes our old banks; but, as a rule, it burrows deeper in the earth than any other species of Wasp. Reaumur states that the holes of Wasps' nests are generally curved. This, however, seems to me to be the exception, and the largest nests generally have short straight holes. It is, moreover, reasonable that this should be so, as the Wasps have less distance to carry out the earth they excavate.

Habits.—To observe the habits and domestic manners of Wasps, I found it necessary that the nests should be conveniently near the house. Any nest may be removed in the following manner, which I have always employed, and found easy and efficacious:—Having found a nest about the middle of July, stop up the mouth of the hole with wet mud, so that the Wasps cannot go in or out. As each Wasp returns to the mouth of the hole, knock him down with a leafy branch, and then quickly seize him, and put him into a glass tumbler, with a piece of board over it for a lid. When all the returning Wasps are thus secured, with a small stick bore a hole in the soft mud, large enough to emit a Wasp, and as each of the Wasps inside issues through this narrow passage, catch, and put him into the tumbler. When all the inhabitants are thus captured, remove the earth from the cells, and gently lift them into a washhand basin; then carry them home, and place them wherever you choose, in a hole six inches deep, and as much broad, with some dry moss under them. Let a piece of stick be fixed over the cells to which the Wasps may attach their nest; place a piece of board over the cells, and bore a slanting hole in the ground for the Wasps to go in and out; and, last of all, empty the tumbler of Wasps into the cells. It seems to be immaterial whether the queen be present or not. Some sugar should be placed near, that they may feed themselves easily during the first twenty-four hours. Next morning they invariably commence to repair the injuries which the nest has sustained. Their first care is to fasten their combs by a strong pillar to the transverse stick, which, I mentioned before, should be placed contiguous to the cells. Without something to which they may attach their nest, they will not build, because, if it cannot be suspended, it must inevitably be destroyed by the damp which exudes from the surrounding ground.

Few animals are so cleanly in their internal economy as Wasps; and their first care after transplantation is to clean their nest from any dirt, &c., which may have fallen into it. This duty is in a measure consigned to the males, who differ materially from the drones of bees, in that they do not live a life of luxury and ease. These males may constantly be seen flying out of the nest, carrying away dead grubs; and often, when these are too large to be carried, I have seen the insect drag its load along the grass after him.

It has often been stated that Wasps keep a sentinel. I am inclined to think that *V. vulgaris* does not. *V. vulgaris* is very particular, at least in a flourishing nest, that the entrance should be quite clear of weeds, straws, and grass, that the activity of commerce may not be interrupted; and there is often a worker employed in cutting down these blades of grass, who might probably be mistaken for a sentinel. At one time I had nine nests which I had removed to within a few yards of the house for convenience of observation, and in none of these could I say that there was a sentinel continually on duty.

Each Wasp takes only ten minutes, or at most a quarter of an hour, in collecting wood or food. This is easily proved by stopping the entrance of the hole, and by killing all the Wasps which return, and in about twenty minutes all will have returned except a few stragglers. Each Wasp, on an average, appears to perform two journeys in an hour.

There is a popular story, originated by Reaumur, and sanctioned by Messrs. Kirby and Spence, and others, that at the first cold of winter Wasps lose all the love for their young for which they were once so celebrated; and that, dragging their unoffending victims from their cells, they scatter their immolated bodies round the entrance to their nests. This statement appears to me to be entirely wrong. Possibly the grubs, in some rare cases, may have been killed by an early frost, and from the number of the dead it might have been conjectured that they were intentionally slain. But it should be recollected that all the Wasps are hatched before the cold weather commences, and about the end of October no grubs will be found in the nest. I have carefully watched many times to observe this tragical *dénouement*, but have hitherto been always quite unsuccessful.

The love which Wasps display both for their young and for the place of their birth is very remarkable. I have seen them linger for upwards of twenty days around some fragment of their cells, when the nest itself had been carried away. Wasps very soon become familiarized with any animal, or with man. I was only once stung by all my Wasps, and then it was because I went in the dark; and they were not in the least disturbed by my presence, or by my taking the glass cover off their nest. I remember, also, once having seen a field mouse and a nest of Wasps share a common hole, and the mouse used to go in and out with perfect impunity. Moreover, the presence of other Wasps does not disturb their equanimity.

On one occasion I planted four colonies of Wasps together, each in a separate compartment, but with four minor holes opening into one large one, like four doors opening into a lobby. They all flourished magnificently; the Wasps of each nest never mistook their own hole, and the most perfect equanimity and good will prevailed. Again, I once bisected two nests, and put the two halves of the dissimilar nests together, and both halves were soon surrounded with a common shell, and amalgamated into one nest.

Mode of constructing the Nest.—The nest is originally constructed by one wasp, the queen, who, about the middle of April, having selected a suitable spot, commences her labour thus:—From a fibre or stone she builds down a short pillar, to the end of which are attached two or three ill-shaped cells; and this is surrounded by a single envelope of paper. I once had the good fortune to see a nest in this state. This nest is constantly enlarged by adding new layers to the outside, and by cutting away the inner layers. All ground Wasps attach their nests to a fibre, or some solid thing; and in this respect their nest resembles that of a tree Wasp, in being suspended from a single point, and not being touched by the surrounding earth. Moreover, the concave surrounding walls of earth are always lined with a parietal layer of paper, independent of the covering of the nest, so that the nest can be taken out quite perfect, leaving this behind.

The material of which the nest is built varies, and is, in point of fact, very characteristic of each species of Wasp. The *V. vulgaris* generally uses very rotten wood, and as far as my observation goes, practically and microscopically, generally coniferous. I have frequently observed the workers cutting wood or palings, and found they always selected the bark of larch or fir.

The workers collect in about twelve minutes little bundles of these ligneous fibres, which seem frequently to be mingled with structures of a fungoid nature, and then, returning to the nest, in about three minutes, roll out the little ball with their hind legs, and, moistening it with a viscid secretion, spread it into paper. Each Wasp seems to have no definite place for working, but commences where his predecessor ceased. When making paper, they are often so occupied that they seem scarcely disturbed by being touched. In some nests, from which I had removed the outer covering, I found that a whole shell for a nest six inches in diameter was built in two days.

The nest of *V. vulgaris* in its natural state is extremely beautiful. It is not composed of envelopes of paper, but of small pieces of brittle substance, placed over each other, as Reaumur says, like inverted cockle-shells. This is obviously a provision against damp, to which, from the deep-seated situation of these nests, they are peculiarly exposed, and is not to be found in the covering of *V. rufa*, which builds superficially in a drier situation. When burrowing, if stones too large to be rolled or carried out of the nest are met with, they are ingeniously excavated under. Having dropped large stones into several nests, I invariably found this to be the case.

Food.—The food of *V. vulgaris* appears to be very various; indeed, this species seem to be able almost to eat anything. In the early months of the year, whilst they are still rapacious, their diet seems to be nearly exclusively animal; but in the later months a vegetable fare seems more grateful to their effeminated natures. They are said to be very fond of bees. They devour raw meat, fish, sweet things of every sort, flies, butterflies, spiders, and they have been observed even to kill dragon flies. I have also several times seen them carry off the grubs from an ant's nest which had been disturbed.

Towards the autumn I have observed a most remarkable phenomenon, that early in the morning our groves—especially beech, fir, larch, and sycamore—actually swarm with Wasps. They chiefly infest the top of the trees, and the immense numbers in which they are occasionally present is most amazing. What their object is I do not know; but it may be to collect the defecations of the various flies which have swarmed there the day before, or it may be to collect the honey dew, the secretion of certain aphides, which is at that time peculiarly abundant. This latter view is probably the correct one, as Mr. Curtis,* when experimenting on aphides, found that their secretions were devoured by bees, Wasps, and ants, as quickly as produced.

The nest which I now exhibit is that of the *Vespa rufa.* At Edgeworthstown this is a very rare Wasp. No history, as far as I am aware, has as yet been given of this Wasp, and therefore the facts I now lay before the Society are of considerable interest. *V. rufa* differs in every respect—in appearance, in size, in habits, and in disposition—from *V. vulgaris.* What the humble bee is to the hive bee, that *V. rufa* is to *V. vulgaris.* He is essentially a stupid Wasp. I believe that he is innocuous to man, not stinging without great provocation, being seldom found in the house, and not devouring fruit and groceries. But the great difference, as far as I know, between the habits of *V. vulgaris* and *V. rufa* is, that *V. rufa* makes paper like the tree Wasps, and *V. vulgaris* does not. Moreover, the nest of *V. vulgaris* is spherical, whereas that of *V. rufa* is considerably flattened at the poles. Again, the *V. rufa* differs essentially from the *V. vulgaris* in not being a burrowing Wasp. Its nest is generally situated quite superficially under the thick moss of dry banks, or in some cavity near the surface already excavated. Occasionally the *V. rufa* builds out of the ground; and I have once or twice found its nests under the window-sill, or in the decayed woodwork round old outhouses. The interior of the nest is most remarkable, for considerably more than two-thirds of the cells are for queens and males. Now, this is a most curious fact. The consequence of this is, that in the autumn the number of queens and males vastly exceeds that of the workers; and that the interior of the nest presents a very formidable, but grand and imposing appearance, from the number of these huge insects everywhere moving about. It is also worth remarking that, though the females are so numerous, this Wasp does not seem to increase by any means rapidly, as we should naturally have expected.

There is still another most remarkable fact in the history of this Wasp yet to be mentioned, and that is, that whereas the nest of *V. vulgaris* is inhabited till late in November, that of the *V. rufa* is almost totally abandoned by the end of September by its queens and all its inhabitants.

V. rufa feeds on small aphides, on honey, which it sucks like a bee from flowers, and on various vegetable products. I gave sugar to some Wasps of this species, and found that it quite enervated them from active work, and they presented all the appearances of intoxication. *V. rufa* is a peculiarly delicate Wasp, and if its nest is at all molested has not the energy to repair the injuries inflicted. The nest of *V. rufa* is composed of various vegetable tissues. I exhibited at the last meeting of the Microscopical Club a specimen of the paper of this Wasp; but no definite conclusion was formed as to the component structures, although it was suggested that the tissue resembled that of the *Urtica urens.*

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* "Linnean Society's Transactions," 1802, p. 82.

Vespa Britannica—the common tree Wasp—is very common in Ireland. Its nest is generally to be found on some branch near the ground. It is particularly fond of building under the branches of young fir trees, or in hawthorn hedges. Of the peculiar situations in which this Wasp is sometimes to be found I give examples. I have twice seen it build in a wren's nest; Mr. Shuchard has found it in a sparrow's nest; and from various communications to "The Naturalist," made at different times, it seems that it is not uncommon for it to build inside a beehive, the nest being suspended from the combs. In all these cases the hive bees were finally overcome, though they continued sedulously collecting honey to the last. The nest of this insect is very beautiful. It is pear-shaped, of a bluish colour, with a few leaves occasionally attached to the outside to screen it from observation. The paper of which its nest is composed is of a very coarse structure.

There is little very peculiar, as far as we as yet know, in the habits of this species. Dr. Ormerod, in an interesting paper in "The Zoologist," distinctly proves that these Wasps always keep a sentinel on duty. He observed that the oldest and most crippled of the Wasps were appointed for this arduous post.

Several years ago I suspended a nest of this species to the ceiling in my room, leaving the upper part of the window open, so that the Wasps might have free access to the open air. Though there were few Wasps at first, yet in a few days they became very numerous; but such is the power which familiarity has in rendering these animals tame, that I was never stung. These Wasps used to go to sleep at sunset, and were up at the first dawn of light. When taking this nest from its original position, I shook most of the Wasps out, and two or three days afterwards I found that they had built a new nest for themselves in the same position. This new nest contained no cells, and was simply globular, composed of thick walls of paper. Four times I destroyed the posthumous nest, and four times they rebuilt it. Now, though *V. vulgaris* will obstinately cling to the spot where its cells were, yet I have never known it to attempt to restore its nest.

Vespa sylvestris, or campanular Wasp, is, I believe, pretty common in many parts of this country. At Edgeworthstown I generally find two or three nests every summer. The appearance of the nest is very distinctive, being of a pale colour, and of small size. The folds of paper cover each other very evenly, like flounces. It builds under dense masses of foliage, and under the thatch of houses, or, in point of fact, in any well-protected situation. There is very little remarkable about its habits, except that it stings with extreme severity when disturbed.

Such is the imperfect outline of the history of the Irish Vespidæ. The subject is full of the deepest interest. Our knowledge of the habits of these insects is still in its infancy. The few facts we know are perhaps crude and imperfect, and it is much to be desired that many of the members of this Society, who are so well qualified for the task, would turn their serious attention to a branch of natural history where so much that is new and interesting remains to be carefully learned and investigated.

The Rev. Dr. Haughton, F. T. C. D., observed that the form of the cell of each of the Wasps alluded to was a matter of interest. He had only examined the cell of the *Vespa Britannica*, or tree Wasp, and he did not know whether it differed in form from the cells of the other species which Mr. Edgeworth had mentioned, or not. The late Dr. Kinahan placed a number of Wasps' nests at his disposal, but he thought they were all those of the *Vespa Britannica*. The facts related by Mr. Edgeworth were of great interest. He was interested particularly by the statement, that the Wasps had the advantage in the struggle for life with the bees. The superiority of the bee in other ways was proved by a variety of facts, as for instance its greater skill in making its cells; therefore it was strange that a savage like the Wasp should be able to vanquish it. Perhaps this was, after all, only what was to be observed among human races. It was an unquestionable fact that the less civilized race, if it had a fair start, would in the end beat down the more civilized race. The doctrine now most fashionable was, that after a certain time civilized races became effete; and Baron Liebig explained the fact by a theory that the civilized human animal suffered an excessive loss of nitrogen and phosphorus. He did not vouch for the theory; but certainly it would appear that after a certain time civilized races did not improve in stature and other ways, to the degree that was expected. He begged to congratulate both Mr. Edgeworth and the Society on the very interesting paper which he had laid before them. He (Dr. Haughton) was an old member of the Natural History Society, and yet he could say that, for originality and power of observation, the paper was one such as they were not often in the habit of hearing.

Mr. Edgeworth said it would be presumption on his part to make any remark about the shape of cells to Professor Haughton, who was an authority on the subject. He had observed that the conical disposition of the cells varied considerably in different nests. This tendency might possibly be due to the different arrangement of the pillars which supported the different layers. In the nest of the *Vespa Britannica* the pillars were aggregated in the centre; but in the nests of the *V. rufa* and *V. vulgaris* the pillars were scattered over the floor of the cells. This, he thought, was characteristic of the nests of ground Wasps.

The Rev. Dr. Haughton stated that, as far as he had been enabled to observe, the nests of all the British Wasps had the cells arranged in a truncated cone. He had nests of Wasps from Madagascar and India, and in these the cells were arranged differently—viz., there were a series of parallel circular planes forming a cylinder, and upon these the cells stood at right angles. The cells of the Bee also were arranged cylindrically.

V.—CATALOGUE OF THE MAMMALIAN FOSSILS WHICH HAVE BEEN HITHERTO DISCOVERED IN IRELAND. By ROBERT H. SCOTT, M. A.

[Read before the Geological Society of Dublin, February 10, 1864.]

INASMUCH as the subject of the Fossil, or rather Sub-Fossil Mammalia of Ireland, has been brought rather prominently before the notice of the Society during the past two sessions, I have considered that it might not be devoid of interest to our members, if I were to place on record the various genera and species of that class of which remains have been hitherto found in Ireland. Such a communication as this does not make any claim to originality, and I shall endeavour, as far as I can, to give my authority for every statement of a fact which will be embodied in this Catalogue. The chief sources from which the information has been derived are Dr. Scouler's papers, in our "Journal," and those by Dr. Ball and Sir W. Wilde, in the "Proceedings of the Royal Irish Academy."

The following list contains those of which notices remain on record:—

1. Ursus arctos.
2. —— spelæus.
3. —— maritimus.
4. Canis lupus.
5. Elephas.
6. Hippopotamus.
7. Sus scrofa.
8. Bos frontosus.
9. Bos longifrons.
10. Cervus alces.
11. —— elaphus.
12. Megaceros Hibernicus.
13. Tarandus rangifer.
14. Ovis.
15. Cetaceans.

In this Catalogue I do not attempt to place on record the circumstances under which the remains have been found, unless in a few instances. To the list which I have given some more might be added; but these I do not consider to deserve the title of fossils,—such are the Fallow Deer, with many instances of Cetacean remains. On this point I need only remind the members that a few years ago an Armadillo was discovered walking about in a field in the county of Meath, having been thrown out of a travelling menagerie, in an apparently dying condition. Another similar instance is to be found in the case of the skeleton of the Lion which was found in the county of Carlow. Fortunately, before the account of this addition to our Irish fossil Fauna was quite ready for publication, an old man turned up who remembered the fact of a dead Lion having been thrown out of a menagerie some sixty years before, which, after having been skinned, was buried in the field.

Bears.—Three species of bears have been hitherto discovered in Ireland, and the progress of geological discovery has been more rapid in respect of this animal than of any other. In 1843, Dr. Scouler noticed that no Bears had been observed in Ireland, and in the year 1846 the discovery of no less than four skulls had been placed on record. There is no record of the existence of Bears in Ireland, as is remarked by Dr. Scouler in his paper on the animals which have disappeared from Ireland.* The oft-quoted statement of St. Donatus, who died in 840, is considered conclusive on this point:—

> "Ursorum rabies nulla est ibi, sæva leonum
> Semina nec unquam Scotica terra tulit,
> Nulla venena nocent, nec serpens serpit in herbâ,
> Nec conquesta canit garrula rana lacu."

The remaining evidence on the subject is entirely negative, and is derived from Giraldus Cambrensis and others. On the other hand, Sir W. Wilde† mentions that there is an Irish name for the animal in an old glossary in the Library of Trinity College, and Thompson mentions the existence of traditions of the animal.

In tracing the fossil Bears, I have derived much assistance from my friend, Dr. W. Frazer, one of our members, who has interested himself much in the matter.

Ursus arctos.—The first Bears' skulls were obtained by Mr. Underwood, who said that he found two in the county of Longford, in 1846. These were bought by A. W. Baker, Esq.

Dr. Ball was permitted to take casts of the two skulls, which he presented to the Royal Irish Academy in 1846;‡ and at the same time he presented a cast of a third skull, which was in the possession of Mr. Cooke, of Parsonstown, and is now in the British Museum. It was found in deepening a river, near Colonel Bernard's property, in the King's County. These casts are now at the Royal Dublin Society. These skulls Dr. Ball pronounced to be those of the brown Bear, *U. arctos*, and in this opinion he was confirmed by Professor Owen, to whom he submitted casts of the skulls.

Mr. Gray discovered the skull of a bear, as described in the accompanying letter:—

"*Clonliffe Parade, January* 24, 1863.

"MY DEAR DOCTOR,—The bear's head to which you referred in your letter of the 10th instant, was found a little above Leinster Bridge, in the barony of Carberry, and county of Kildare. It was imbedded in peat or sand, about four feet below the surface, in a sort of valley or hollow, through which the River Boyne flowed; and if you refer to the fifth volume of the 'Proceedings of the Royal Irish Academy,' p. 53, of the Appendix, you will find a report of mine, describing a lot of articles found while engaged in the arterial drainage of some important rivers in Kildare, Meath, Westmeath, and the King's County. These are all in some degree descriptive of the locality; and if you are following up the subject, you may derive some ideas from the facts I have stated. The bear's head was got along with a great quantity of the bones and heads of the deer; and they were collected together in a position that would give the idea of their having been floated together, and deposited in an eddy or bend still of the river. There was a quantity of the bear's bones along with the head when it was found, but they were destroyed by the men who found them, *although they were not much decomposed*. Some of them were very short and strong—not such as you mentioned to me, but were, perhaps, nine inches in circumference, and about fifteen inches in length. They were destroyed by the men having used them to knock the earth out of the barrows, &c., by striking them till broken.

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* "Journal of the Geological Society of Dublin," vol. i., p. 228.

† "Proceedings of the Royal Irish Academy," vol. vii., p. 193.

‡ Ibid., vol. iv., p. 416.

"There was no marl in the neighbourhood. If you refer to page 35 of Appendix to vol. v. of the Royal Irish Academy's 'Proceedings,' before referred to, you will have a description of the locality. The bone dirk (No. 15) alluded to was found about half a mile or less below where the bear's head was got, and in the same river course.

"I suppose you have seen the skull; it is in the Museum of the Academy, and I suspect about the most perfect of its class. Any other information I can afford you relative to such matters will afford me much pleasure; and I trust you will excuse my not having replied to your letter before this.

"Yours faithfully,

"*William Frazer, Esq., M. D.*" "RICHARD A. GRAY.

It was presented by him to the Royal Irish Academy, among the donations from the Board of Works, and is now at the Royal Dublin Society. It is figured by Sir W. Wilde.*

In March, 1859, Mr. Brenan and Dr. Carte discovered some remains of *U. arctos;* among others, a mutilated cranium, in the cave at Dungarvan.† The other bones were—the left lower jaw, the atlas, two cervical, two dorsal, and two lumbar vertebræ, with several broken ribs.

About the year 1860, Mr. Going,‡ of Violet Hill, Broadford, county of

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* "Proceedings of the Royal Irish Academy," vol. v., App., 54, vii.

† "Journal of the Royal Dublin Society," vol. ii., p. 451.

‡ On applying to Mr. Going for further information on this subject, I received the following letter, which he has kindly permitted me to print:—

"*Violet Hill, Broadford, June* 20, 1864.

"SIR,—I beg to acknowledge the receipt of your letter of the 17th inst., and will feel happy at affording you all the information I can relative to the finding the animal remains you allude to in this locality.

"Some years since, my men, in draining a small boggy hollow, found a quantity of bones under the bog, in the blue clay. The bones were evidently those of some animal *much* larger than any dog, being stronger in proportion to their length, and exactly similar, as far as I and some friends could judge, to the skeleton of a large Bear. The skull was about twelve inches long, but the nose part was broken off, and very much resembled the *shape* of a badger's skull, but about the *size* of a large Bear's. Most unfortunately, I regret to state, these bones were not preserved. The skull was kept for some time, but has been lost; but for which I should have much pleasure in sending it for your examination. Near the place where these bones were found, in a few days after, two large *tusks*, about eight or nine inches long each, were also turned up, with several teeth also, besides some bones and skulls of other animals, which were found in a bog, in a wood, when raising some large *black* oak trees, several feet under the surface. The latter skulls resembled the first alluded to, but were of smaller size. I regret very much now that I have not preserved them, with the exception of an Elk's head and antler, which I have

Clare, discovered a skull, about twelve inches long, and of the shape of the skull of *U. arctos.**

Lastly, within the last year, Mr. W. H. Gregory, M. P., of Coole Park, near Gort, kindly offered to examine the caves in his park with Mr. Jukes, who has furnished me with the following account:—About 100 yards from the mouth of the cave, which is in low ground, and full of water in wet weather, a crust of stalagmite was broken through. This was in some places eight or ten inches thick; underneath it was an irregular mass of fine brown clay, from two to four feet thick. After digging out a great quantity of this clay, without finding anything at all, the bones of a small animal were at length met with, and among them a small fragment of a jaw, with two teeth in it. This fragment was afterwards examined by Mr. Blyth, and the teeth said to be the hindmost false molar (or carnassier), and the next false, or premolar, of a young Bear (*Ursus arctos*), being the deciduary or milk teeth of the right side of the upper jaw.†

U. spelæus.—Portions of the skeleton of this species, probably of a female specimen, were discovered among the other bones found at Shandon, Dungarvan. The cranium was not discovered, but the bones which were found exhibited the marked characteristics of *U. spelæus.*

U. maritimus.—At the January meeting of the Society, Dr. Carte announced the discovery of a few bones of an animal belonging to this species at Lough Gur. The recollection of his paper is so fresh, that I need hardly remind you of it. The account will be found at p. 114, vol. x., of the "Journal." In this case, as in the foregoing, the cranium has not yet been found.

In Archdeacon Maunsell's well-known letter about the skeleton of the Megaceros at the Royal Dublin Society's Museum, printed in Dr. Harte's pamphlet, he mentions the discovery of a head of a large Dog, at least of a carnivorous animal, which was found with the Deer at Rathcannon, county of Limerick. It has been supposed by some to have been a Bear; but Archdeacon Maunsell would hardly have called it a Dog, if it did not closely resemble a Dog's skull.

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heard stated is the largest found in this county, but not in the same place in which other remains were discovered. All those I allude to were clearly belonging to extinct animals.

"I have the honour to remain, Sir,

"Your obedient servant,

"*R. H. Scott, Esq.*" "W. Quin Going.

* Explanation to Sheet 133 of the Map of the "Geological Survey of Ireland," p. 34.

† With reference to this identification, I have to subjoin the following letter, received since from Mr. Jukes:—

"*Dublin*, *May* 10, 1864.

"My dear Mr. Scott,—I took over to London the other day the teeth which were found in Coole Park, and which Mr. Blyth informed me were those of a young brown Bear, and asked Professor Huxley to give me an opinion upon them. He examined them, and said they belonged to a young pig. So this case of the occurrence of *Ursus arctos* in reland fails.

"Yours very truly,

"J. B. Jukes."

Canis Lupus.—The remains of Wolves and Dogs can hardly be distinguished one from the other. There are several skulls of a canine type which have been found in Ireland; some of them are said to be those of Wolves. Several such specimens were obtained from Dunshaughlin.

The date of the extinction of Wolves is well known. In 1641, they were extremely troublesome. In 1652, a council order of Cromwell's government was made at Kilkenny, which prohibited the export of Wolf-dogs; and the reward for a bitch Wolf was £6; for a dog, £5. Smith, in his "History of Kerry," says the last was killed there in 1710. Mr. Hardiman, the editor of O'Flahertie's "Description of Iar-Connaught," pp. 10 and 180, gives some information on the subject, and says that the date of the death of the last Wolf in that district was 1700, as far as he could ascertain.

Elephas primigenius.—In the year 1715,* four teeth of an Elephant were found by Mr. Francis Nevil, at Maghery, eight miles from Belturbet, in sinking for the foundation of a mill. The finder did not know to what animal the teeth belonged, but suspected them to be Elephants' teeth; and this opinion was placed beyond a doubt by Dr. Thomas Molyneux, in an interesting letter, which follows the original communication.

In the year 1859,† Mr. E. Brenan, of Dungarvan, discovered a considerable portion of the skeleton of an Elephant in the cave at Shandon, near that town. These bones were associated with those of Bears and numerous other mammals.

In addition to these remains, Smith, in his "History of Waterford," p. 58, mentions the discovery of the rib of an Elephant within a mile of Whitechurch, not far from Dungarvan. He gives a figure of the rib, on a reduced scale, and it appears to resemble the rib of a Whale. It is quoted by Professor Oldham, in a paper read before the Geological Society of Dublin, on the 12th of June, 1844,‡ as the rib of a Whale, without any reason being assigned for its being so called.

Hippopotamus.—When the Ordnance Survey was in progress in the county of Antrim, in the vicinity of Carrickfergus a tusk of a Hippopotamus was found by a son of Mr. P. Doran, as will be seen from the accompanying letter, which I have received from my friend, Dr. David Moore, the Curator of the Glasnevin Botanical Gardens:—

"*Glasnevin, February* 5, 1864.

"My dear Sir,—I have a clear recollection of the circumstance you mention about the tooth being found near Carrickfergus. Mr. Jukes applied to me some time ago to furnish him with all the information I could on the subject, which I did. The occurrence happened as follows:—In 1837, our office was in the Infantry Barracks, at Belfast. I had attached to my party several assistants, one of whom was the son of Mr. Patrick Doran, the mineral collector, whom I sent to Carrickfergus to collect plants, birds, fossils, &c. In his peregrinations he picked up the tooth in question, on the side of a stream, about a mile or less north-west of the town, on the rising ground towards the mountain. He described it to me as having been partly sticking out from a bed of gravel. I went to see the place afterwards, and, unless the locality be greatly altered since, would easily find it again. I gave the specimen (as was my duty) to General Portlock, who was then the commanding officer of the Geological and Natural History Departments.

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* Boate, "Natural History of Ireland," p. 128.

† "Journal of the Royal Dublin Society," vol. ii., p. 251.

‡ "Journal of the Geological Society of Dublin," vol. iii., p. 70.

"Faithfully yours,

"*R. H. Scott, Esq.*" "D. MOORE.

Sus.—A great number of Pigs' skulls have been discovered, especially in Lough Gur. These all belong to the old Irish long-faced variety, which is now fast disappearing. Many of them show the mark of the pole-axe on the forehead.

Bovidæ.—As regards the bovine animals, it has long been known that there are in Ireland two well-marked species of Oxen, whose remains are found fossil.

The gigantic species which is found in England, *Bos primigenius*, does not occur here, or at least has not been as yet discovered. The two species which are found, and of which specimens were presented by the Royal Irish Academy to the Royal Dublin Society, are the *Bos frontosus* of Nillson, and the smaller species, *Bos longifrons*. Several of the skulls exhibit the mark of the pole-axe.

In a recent communication made to the Royal Irish Academy,* Mr. Blyth stated that the skulls which he found here were exactly similar to those found at Uriconium.

Cervidæ. Cervus alces.—A horn of the true Elk is said by Thompson to have been found, in the county of Tyrone, by a relative of his own. It was dug out of a bog near Stewartstown, and was presented to the Natural History Society of Belfast. Mr. Thompson mentioned the discovery in the "Proceedings of the Zoological Society of London" for 1837, and this notice was copied into his "Natural History of Ireland." With reference to this, Dr. Carte has received the following letters from Mr. Robert Patterson, of Belfast, which he has permitted me to print:—

"*Belfast, February* 10, 1864.

"MY DEAR SIR,—As my friend, Mr. Hyndman, knew better than myself about the elk's horn in the Museum, I sent him your letter, and enclose his reply.

"Yours very sincerely,

"*Dr. Carte.*" "ROBERT PATTERSON.

"'*February* 9, 1864.

"'MY DEAR SIR,—I have examined the elk's horn in the Museum, and I think the freshness of it, and the perfection of the points or tangs, forbid the supposition that it could ever have remained any lengthened time in the bog. Besides the paint upon it, mentioned by Thompson, there is a round hole bored through the broad plate of the horn, showing that at some period it had been put up as an ornament in some person's hall. It must have got into its position in the bog by some accident.

"'Yours very truly,

"'*Robert Patterson, Esq.*'" "'GEORGE C. HYNDMAN.

This opinion of Mr. Hyndman has derived additional confirmation from a communication which I have received from a friend of mine, Mr. Bernard R. Ross, F. R. G. S., of the Hudson's Bay Company's Service, who, on examining the horn, pronounced it to be a North American specimen, and of no very great antiquity.

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* "Proceedings of the Royal Irish Academy," vol. viii., p. 472.

Cervus megaceros.—The instances of the discovery of this animal are so numerous, that I shall only give a few instances of their being found in juxtaposition with bones of other animals and with other articles.

It is, however, necessary to examine evidence of this nature with great care before receiving it. In the course of a discussion which took place before this Society on the 11th December, 1861,* some facts of interest were elicited. Dr. Petrie said that he had in his possession an iron sword which had been found, with the bones of a Megaceros, in the county of Meath; and Mr. Baily referred to the discovery of remains of the Megaceros which were found with spear-heads and pottery in a lake, in the canton of Berne, in Switzerland, as mentioned by Professor Morlot. The discovery of jet rings with the specimen in the Museum of the Royal Dublin Society, as noticed by Archdeacon Maunsell, was also alluded to. Two quotations from the "Book of Lismore" have also been recently brought under our notice, in which the chase of a large deer, supposed to be the Megaceros, is described. One of these was read on the evening to which we are referring, and the other in the course of Dr. Carte's paper on Lough Gur, which appears in this volume of the "Journal."

In a paper by Mr. H. Denny, of Leeds,† "On the Claims of the Gigantic Irish Deer to be considered as contemporary with Man," there is a long discussion on this subject, from which I extract the following statements, which I have not verified personally:—The leg of a Megaceros, with a portion of the tendons, skin, and hair on it, was found in the county of Wexford, on the estate of H. Grogan Morgan, Esq., at Johnstown Castle. This specimen was sent to the Royal Dublin Society, and was exhibited by Mr. Peall, Professor of Veterinary Surgery, at his lectures.‡

A very scarce book—a "History of Ireland," which is said to be by Peppard, and was published in the seventeenth century—contains a statement to the effect, that the ancient Irish lived on the flesh of a great black Deer; and similar information is said to have been obtained by the late Sir W. Betham from some brass or bronze tablets, containing an inscription. This fact was mentioned by Mr. Glennon, of Suffolk-street, who with Mr. Richardson carried on a long discussion on this subject in 1846, in the "Zoologist," and elsewhere. Several instances of the finding of bones of the Megaceros in company with other remains are given by Mr. Denny, to whose paper I must refer you. In addition to the facts and statements just quoted, there is the evidence which may be derived from the existence of cuts, &c., on antlers and bones of the giant deer, which was discussed at considerable length by Mr. Jukes, and by the members who were present when his paper was read, in December last.*

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* "Journal of the Geological Society of Dublin," vol. ix., p. 339.

† "Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire," vol. iii., p. 400.

‡ Unfortunately, this specimen appears to have been mislaid, and cannot now be found.

It will be seen from what I have mentioned, that the evidence on this subject is in an unsatisfactory state; and although it is certain that the date of the extinction of the Megaceros in Ireland is, geologically speaking, very recent, yet it is still a matter of opinion as to whether man was or was not the agent of its extermination.

Cervus elaphus.—The fossil Red Deer is as abundant as, and even more so than, the preceding species. Some of the antlers found are very magnificent. One obtained at Ballinderry Lake, county of Westmeath, presented to this Society by Mr. Hamilton, in 1843, had nineteen points. A hundred years ago they were still very abundant in Erris and in Kerry. In the ninth century, Giraldus speaks of them as very fat, and therefore unable to escape from their foes; and O'Flahertie, in his "Description of West Connaught," written in 1684, mentions them, p. 121. They are generally known under the name of Marsh Deer, and Professor Haughton is of opinion that they are a variety of the Red Deer.

Cervus Dama.—Among the bones presented by the Royal Irish Academy to the Royal Dublin Society, there is a fragment of an antler of a Fallow Deer, described as an antler of a young Red Deer in the "Catalogue of Unmanufactured Remains." This is evidently not a fossil, as the date of the introduction of the Fallow Deer into the Continent of Europe is known. Thompson mentions the discovery of a Fallow Deer in a bog in the county of Antrim. The specimen was in his possession.

A skeleton of a Fallow Deer, with a silver collar round its neck, was found at the same time as Mr. Cooke's Bear's skull, before referred to. It had belonged to some member of Lord Rosse's family.

Tarandus rangifer.—The history of all the specimens of this animal which have been discovered in Ireland was read before the Society in May, 1863, by Dr. Carte, and is printed in vol. x. of the "Journal," p. 103.

Ovis.—In the collection of Mammalian remains at the Royal Dublin Society, which have been deposited there by the Royal Irish Academy, there are several skulls of Sheep, and a few Goats' skulls. Of the Sheep there are two well marked types—one possessing several horns, like the polycerate Sheep, at present existing in Iceland, and the other identical with the horned Sheep of the Highlands of Scotland, according to the notice published by Dr. Blyth, and before referred to. The same authority considers the Goats' skulls to be very recent.

Cetaceans.—Professor Scouler found the rib of a Whale in the marl beds of Wexford, as mentioned in his Presidential Address for 1844.† In addition to this, remains of the smaller Cetaceans are not uncommon in localities near the sea side. There is a vertebra of a small Whale, or perhaps of a Porpoise, among the fossil bones in the Royal Irish Academy's collection. On this subject I may observe that a shoal of Ca'ing Whales was driven ashore some years ago on the sands to the west of Horn Head; the skeletons were buried in the sands.

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* "Journal," vol. x., p. 127.

† "Journal," vol. iii., p. 18.

VI.—On the Occurrence of Hymenophyllum Tunbridgense (Smith) in the Co. Longford, with a List of Stations of Cystopteris fragilis (Bernh.) in the Midland Counties. By F. J. Foot, M. A., F. R. G. S. I., Corresponding Member.

[Read before the Natural History Society of Dublin, April 1, 1864.]

I AM happy to be able to record the occurrence of *Hymenophyllum Tunbridgense* in the county of Longford.

Having been lately on a short geological tour in that part of the country, I came across a considerable exposure of conglomerate rocks, forming rather bold crags, on the east side of the road leading from Longford to Ballymahon, about six miles south of the former. It was just at the junction of the townlands of Commock and Curraghmore, on the western extremity of Slieve Ardagh, a low hill of Old Red Sandstone, which, rising here from the limestone plain, extends eastwards to the little village of Ardagh. It at once struck me as being a likely spot for Hymenophyllum, and my conjecture proved true; for, after a short search, I found the plant growing at the foot of a low cliff of conglomerate, having a western aspect. I only found one tuft, or small mat of it; indeed, it was raining so heavily at the time, that I was contented with establishing the fact of its existence at the place, and did not look for more.

Further north and north-west, both in the counties of Longford and Roscommon, the Old Red forms several other hills in the plain, protruding through the low lying and level limestone ground; and I have no doubt that when the conglomerate or grit rocks crop out in bluffs or crags, as they do here, *Hymenophyllum Tunbridgense*, and probably *H. Wilsoni* also, will be found to occur. My colleague, Mr. G. H. Kinahan, tells me that he found Hymenophyllum on every conglomerate crag on the Slieve Aughta hills, in the counties of Clare and Galway.

These newly recorded stations, in addition to the old and well-known ones of the county of Wicklow, and the mountains in the south-west, give the Hymenophyllum a very extended range in Ireland. Its habitat is always on the older rocks, and particularly those of the Old Red Sandstone. Why is this? We do not find it on limestone, because a calcareous soil is injurious to the welfare of the plant. But why do we not meet with it on the quartzose grits and sandstones of the Coal measures, which frequently, as in the counties of Cork, Kerry, and Clare, form wild hills, with rugged crags and cliffs, apparently well suited for Hymenophyllum? I believe this to be a question intimately connected with the geological history of the country.

In conclusion, I give a list of the localities where I have observed *Cystopteris fragilis* in the midland counties:—

1. Two miles south-east of Ballymore, county of Westmeath, close to the cross roads near Clare Castle, on the north-west side of the road running south-west from the cross.

2. Five miles W. N. W. of Athlone, and one mile and a half S. S. E. of Brideswell, on the east side of an old road bearing north and south county of Roscommon.

3. Near Lissanisky, four miles south of Knockcroghery, on the north side of an old road, bearing east and west, county of Roscommon.

4. Three miles S. S. E. of the hamlet of Thomas-street, and seven miles north of Ballinasloe, on west side of high road, bearing S. S. E., county of Roscommon.

5. Half a mile east of Thomas-street, on the north side of high road, which bears east and west.

6. Two miles north of Thomas-street, on west side of high road, which bears nearly north and south, and in chinks of limestone crags, west of the road.

7. Two miles south-west of Ballinasloe, on south-east side of Old Aughrim-street, which bears south-west and south-east, county of Galway.

8. Two miles and a half S. S. W. of Woodlawn station, on the north side of old road.

Thus, counting the Thomas-street stations as one, we have in a triangular space, with an area of about 250 square miles, in the very centre of Ireland, six stations for *Cystopteris fragilis* hitherto unrecorded. I have been particular in mentioning on which side of the road the fern grows, as it seldom or never grows on both sides at the same place.

Dr. Moore, in expressing the interest with which he had heard Mr. Foot's communication, adverted to the comparatively slight advances which had as yet been made in an accurate knowledge of the botany of the midland counties; and expressed a hope that Mr. Foot would continue to have a look after plants of rare or peculiar occurrence. Mr. Foot's present record of the occurrence of *Hymenophyllum Tunbridgense* showed a large range for this fern south and west; and he (Dr. Moore) had just received very fine specimens found in the county of Donegal by William Harte, Esq.; but it did not occur, that he was aware of, in the counties of Derry or Down, whilst in those counties, and at Cave-hill, near Belfast, *H. Wilsoni* abounds. This latter was the species which occurred in Wicklow, and the two forms seemed to show a distinct geographical distribution. Should a new edition of the "Flora Hibernica" ever be published, he hoped that special attention would be devoted to this element—the geographical distribution—upon Mr. Hewet Watson's plan, which Dr. Dickie had to a considerable extent adopted in his recently published "Flora of Ulster, and Botanist's Guide to the North of Ireland."

Dr. Grimshaw exhibited fronds of *Hymenophyllum Tunbridgense*, gathered at Crownard Mountain, near Killybegs, county of Donegal, during last spring. The plants were then in a sterile condition, but had since, in cultivation, fruited freely.

The Chairman stated that both species had been found by the Right Hon. John Wynne, in the county of Sligo.

Mr. Archer referred to Dr. R. W. Smith's record of both *H. Tunbridgense* and *H. Wilsoni* near Sir A. Brooke's seat, in the county of Fermanagh, in 1860, in the "Proceedings" of this Society, remarking that this came in to help to complete the chain of westward distribution.

Mr. Good, judging from his experience of the distribution of marine animal life, and arguing from analogy, would suggest that probably the geological formation had even more to do with the distribution of various species of plants; he had obtained the oxhorn cockle, and Norway lobster off Helvick Head, county of Waterford.

The Rev. Dr. Haughton considered Mr. Good's suggestion well worth attention. While peculiarities of climate were doubtless very important, the conditions of soil were also very influential in regulating the distribution of forms of life, more especially of plants. At Lizard Point, in Cornwall, this had forcibly struck him. There the soil was serpentine, containing silicate of magnesia; and some of the common species of plants of the locality had arrested his attention by their peculiarities, whilst the same species were not, perhaps, to be found many miles from their own limited district. Again, often from the chemical composition of a rock can be predicted the kind of fossils to be found in it. Dr. Haughton referred to the foxglove, which, as is well known, avoids the limestone; and as to Mr. Foot's statement in a previous communication, that he had found it on that formation, he (Dr. Haughton) believed that Mr. Foot had modified his opinion as to its being found on pure limestone. Some considered it to be restricted to certain limits as regards the sea level, but it so happened that that often coincided with the limestone.

Mr. Foot stated that the foxglove alluded to by him had been found on argillaceous limestone. Heaths, too, dislike pure limestone; and wherever they occurred on limestone, one might always look for siliceous beds. In Cornwall, *Erica vagans* grows on serpentine, and one might draw a geological boundary by tracing that of the heath.

Dr. Moore considered the plants which had been mentioned—*Digitalis purpurea* and *Erica vagans*—as the two most "geological" in their tendencies; and whilst some might show certain predilections, he did not know of others which were at all strictly so. He had seen, in the county of Antrim, where varieties of soil occurred, the foxglove close to limestone, growing in a *debris* of other rocks, but never in pure limestone. In regard to the heath, all the Ericaceæ disliked limestone; he might especially instance Rhododendron, which died therein, as if poisoned.

Mr. R. L. Edgeworth, as the attention of the meeting had been directed to Ferns, took the opportunity to place on record the discovery in the county of Longford of *Polystichum lonchitis* (Roth) (= *Aspidium lonchitis*, Swartz et auct.). Contrary to previous experience, this plant had been found on the road side, under an old hedge, growing between loose stones.

VII.—ON FLIGHTS OF SWANS SEEN IN THE COUNTIES OF ROSCOMMON AND GALWAY, DURING THE WINTER OF 1863-64. By F. J. FOOT, M. A., F. R. G. S. I., Corresponding Member.

[Read before the Natural History Society of Dublin, April 1, 1864.]

THE River Suck has always been a favourite resort for Swans during severe weather, as also are some of the small loughs, particularly Lough Funshinagh, in the county of Roscommon. This winter considerable numbers of Swans have been observed at different times, and in different places, in the neighbourhood of the Suck and Shannon, in the counties of Roscommon and Galway.

I give the following observations made by myself and others:—On January 20, north of Woodlawn, I observed a small flock of five Swans flying very high, in a direction of south by east, or so, uttering occasionally a low dismal cry. They were too far from me to note their species. The day was cold and showery. February 22. I saw a party of nine feeding on the banks of the Suck, a little below the town of Ballinasloe. There was a severe frost at the time. They were about one-third of a mile from where I stood. I could see by the aid of of a telescope that they were not the tame or mute Swan (*Cygnus olor*), as they had not the black knob or orange bill; but I could not distinguish whether they were *C. ferus*, or *C. Bewickii*; some of them (I forget now the number), I could see were young ones by the grey plumage. Feb. 26. In the morning, a little north of the town of Ballinasloe, I saw five Swans flying high in a direction about south-east. I cannot say what was the species. The day was very calm and bright, with a hard frost. On the evening of the same day I saw nine flying high in the same direction, or, perhaps, with a little more of east—species also undetermined. March 25 and 26, a small flock of four Swans was seen feeding on the banks of the River Suck, a little below the town of Ballinasloe. On these two days the weather was very rough and cold, but we had several fine days before them.

I have obtained the following information from Captain Ingham, now quartered in Athlone, and an indefatigable sportsman. I had been informed that on one of his duck shooting excursions he had been so fortunate as to shoot six Swans in one shot. I wrote to him, asking him to what species they belonged, and his reply is so interesting that I venture to quote it:—

"*Athlone, March* 24, 1864.

"DEAR SIR,—I shall be most happy to give you any information in my power about the Swans, or any other sort of wild fowl; and I only regret that I did not hear from you earlier, as I could have got you a specimen almost any day; but I never shot at the Swans except on the occasion you refer to, and once afterwards, when I got four. Both times I only did it 'out of spite,' as they had been spoiling my shots at widgeon all the day. When I got the six it was quite dark, and I only shot by the sound. They were on very shallow water, evidently feeding, as their throats were full of the roots of the short grass. They are what are commonly called 'hoopers,' which, I believe, is the common wild Swan. There certainly must have been a much larger migration of swans this year than for very many years, as I have frequently been told that 'ten or twelve years ago you might see thirty Swans together.' Last year I only saw two, and the year before six; this year, when the whole flock was collected, there were about 400 birds. On one occasion I counted 174, which appeared to be the smaller half of the flock. Their first appearance was on the 5th October, when fifteen were seen flying up the Shannon, i. e. in a northerly direction; but I think they were only passing, as I never heard of them again. On the 26th November I saw six, two old and four young; one of the young ones was shot, and I think the other five remained there the whole winter, keeping apart from the large flock which arrived later. The first time I saw the large flock was on the 21st of January, on the Suck, and I was told that they had been there two or three days; they were evidently quite strangers, as, when they were disturbed, they went anywhere without any definite intention, which was not the case afterwards. The last time I saw the whole flock together was on the 26th February, on Lough Funcheon (or Funshinagh, a shallow lough, about two miles long, and three-fourths of a mile wide in the broadest part, about seven miles north-west of Athlone, county of Roscommon); the Suck was too low for them, and I think that most of them left shortly afterwards, though I saw about forty on the 16th March. The weight of those I shot was about 14 lbs. each."

Captain Ingham concludes his letter thus:—"If I can give you any information about other sorts of wild fowl, and I think I have seen more of them than any one else about here, I shall be most happy to do so. There were an unusual quantity of pintailed ducks here this winter. Last year there were a great many crested grebes; this year there are very few; I have not shot one. I got a beautiful pair of eared grebes last year, and, as all who saw them said they had never seen the bird before, I presume they are very rare in these parts. The white-fronted is the common goose here, the grey and the brent are scarce, and I once saw three barnacle."

From this very interesting communication of Captain Ingham, showing so much close observation, it would seem that a large flock of 400 Swans, or thereabouts, arrived about the middle of January, and took their departure towards the end of February. They were probably preceded by small flocks which began to arrive early in October, and after their departure, perhaps some stragglers remained. Some of the small flocks alluded to may have been quite independent, and never joined the large flock. Query, may not some of these have been a different species, either *C. Bewickii* or *C. immutabilis?* Probably, during their short sojourn, which may be looked on as a mere rest during migration, the large flock divided into smaller ones, which scattered over the neighbouring lakes in different parts of the Suck and Shannon, in search of food.

At Shannon Bridge, eight miles south-east of Ballinasloe, five Swans were seen on the 16th of January, flying in a westerly direction. On the 20th of January, a flock of twenty-eight was observed flying south; three remained about Shannon Bridge for a week.

On February 9th, two miles east of Oranmore, Mr. G. H. Kinahan saw ten Swans flying south; they were very low, and he thinks they were *C. ferus*.

I have also received the following information from him, in two communications, which he obtained, at my request, from friends living in the neighbourhood of Lough Derg. One of them, a gentleman living at Tomgraney, says:—

"On the 8th of February last, I met a large herd of Swans flying round Parker's Point into Youghal Bay, in column, along the surface of the lake. I counted seventeen birds, but have heard of no others in this locality this year. I have no doubt that they were the common wild swan, *Cygnus ferus*, or Hooper. . . . . In 1860, I shot two wild Swans in the lake near Coolreagh—Lough O'Grady, I think, they call it."

The other gentleman, a resident at Mount Shannon, says:—"Two flocks only were seen in this neighbourhood this winter. The first flock, consisting of six Swans (the large white ones), were observed on the 5th January, 1864, flying towards the south, very low, over Lough Derg. The second flock, consisting of eleven (large white Swans), were observed flying over Holy Island, on about the 13th January, 1864, towards the south. None pitched at their usual resting-place (mouth of Bow River) this or last year. The year before I fired at a flock of twenty-one Swans there. Five or six appeared smaller than the rest, and of a cream colour."

Mr. R. P. Williams would confirm the record of the extraordinary immigration of wild Swans which had taken place this winter. A lake belonging to a friend, near Newcastle, county of Meath, in the month of February was for two days covered with Swans; they then flew away. On the Shannon a few occurred every year, but this winter their numbers seemed to be quite unusual, and were very remarkable.

Dr. Grimshaw stated that wild Swans had been seen in great numbers near the town of Donegal; and Mr. Lalor mentioned that large flocks had been seen near Athy.

VIII.—NOTES ON SOME DISSECTIONS OF THE FRESH-WATER PEARL MUSSEL (UNIO MARGARITIFERA). By JOHN BARKER, M. D., M. R. I. A.

[Read before the Natural History Society of Dublin, April 1, 1864.]

THIS Lamellibranchiate Mollusc is of the Family Unionidæ, Suborder Asiphonidæ, and Order Conchifera, and is found very widely distributed; it is closely allied to those Molluscs which possess siphons, in fact the edges of the mantle are only united in the position where true siphons exist. The Pearl Mussel is found abundantly in the British Isles, in mountain streams, and is still gathered in dry seasons, for the sake of the pearls which they frequently contain. These are generally found in the fold of the mantle, and near the inferior adductor muscle, and are caused by some irritating substance which has been covered layer over layer by nacre; those in the free part of the mantle are often nearly spherical, and vary in beauty and colour according to that part of the mantle in which they are found; their size, too, varies, as the source of irritation and the age of the Mussel. A very fine pearl from a Unio, said to have been found in Cornwall, is now in the British crown.

I am indebted to Dr. Carte for the specimens now exhibited; they were taken in Kerry, and have been submitted to careful examination. Two pearls were found, but they were of no commercial value. It is astonishing how little is known of the anatomy of Molluscs; and very often (as in this case), when the investigator wishes to ascertain what is known on the subject, he is compelled to refer to obscure periodicals, or to go back to the older anatomists, as Bojanus and Poli, and others of that class, to arrive at original observations. The manuals at present in use are mere compilations, in which mistakes and incorrect diagrams are too often sedulously copied without investigation, while the observations of the older writers are obscured by the terms and diction then in use.

Those portions of the anatomy of the Unio to which my attention was more particularly directed were the alimentary canal and nervous system; and as I have not found these important parts either described or figured exactly as they appeared to me, I thought it might be useful to lay these dissections before the Natural History Society.

The alimentary canal of the Unio is of extreme delicacy, and is for the most part covered by a tough muscular envelope, forming the base of the foot of the animal, which latter consists of layers of muscle spreading in different directions, and connected together with distinct fibres, not generally muscular. These distinct fibres in the neighbourhood of the intestine and nervous system form a series of bars transverse to the course of the intestine, and serve, in my opinion, to prevent undue pressure on the intestinal canal and nervous system on the contraction of the strong muscular foot; they form also interstices in which the water-vascular system is situated, on which depends so much of the turgescence and power of the foot. The presence of these tough trabicular septa, and the great delicacy of the intestinal canal in close approximation to them, render the dissection of this part a labour of difficulty and patience, and require that the investigation should be carried on under water, with the aid of a good lens. The mouth, which is large, admitting a glass rod of about a third of an inch in diameter, is furnished with four leaf-like labial tentacles, and leads to a stomach capable of containing a bean; the walls of the stomach are thin, and covered with a salivary glandular substance, the ducts of which receive freely injection thrown into the stomach; the intestine commences narrow and valvular, and courses three-quarters round the bulk of the liver, making three sharp turns on itself, then passing under or rather on one side of the stomach, and thence through the pericardium and heart, terminates behind and below the inferior adductor muscle. In this course it is of nearly uniform diameter, about the size of a crow quill, and is capable of considerable distention. As far as I can judge, there are free communications between the alimentary canal and the water-vascular system, so as to admit of the foot being contracted suddenly, and the water expelled by mouth or water pore, or both.

I think the specimens on the table, which are intended for the Museum of the Royal College of Surgeons, exhibit these structures distinctly; with regard to the nervous system, it is also shown in one of the preparations, which exhibits the well-known distribution of the nerves in the Lamellibranchiate Mollusca. I may remark that distinct branchial ganglia are found on the nerves supplying the gills: I have failed hitherto in demonstrating, however, the auditory capsules in the Unio.

Mr. J. B. Doyle observed that he had found the Pearl Mussel in several parts of Ireland. Some years since, when travelling in Donegal, he procured some fine specimens of pearls from the rivers in the vicinity of Letterkenny. At that time there was a revenue officer at Ramelton, who realized more by the sale of pearls than by his situation. The habitat of the Pearl Mussel he had found almost invariably to be in deep pools of rivers which flow through alluvial or marshy bottom lands. It is often extremely difficult to see the Mussels, in consequence of the shells being of the same colour as the mud in which they are imbedded. The favourite season for taking them is during the summer months, when the rivers are low. Selecting a calm bright day, the fisherman sallies forth, armed with a sparp-pointed wattle and a large wooden scoop. Having stationed himself upon the brink of the pool, he waits until he sees some of the Mussels move, but which they do with great rapidity by the aid of their strong muscular foot. Sometimes they lie basking, as it were, in the sunshine, the foot extended, and mantle visible. They thus form a conspicuous object at the bottom of the pool, and a convenient mark for the fisherman, who instantly thrusts his pointed stick between the valves, and thus lifts the shell cautiously out of the water, repeating the process as long as he finds an open shell. Having thus discovered the situation of the bed, he wades into the pool and shovels them out by wholesale on the bank. The heap is then carefully examined, and all the deformed and wrinkled shells are selected, as likely to contain the best pearls. The residue, or healthy Mussels, are also carefully examined, although, generally speaking, with little success. Some years ago he (Mr. Doyle) saw an extensive pearl fishery at Portglenone, on the Bann. At this place it was customary to throw the Mussels into a large heap to decompose, which they do very rapidly. They were then taken and washed in large tubs, the mass of shells and pulp being stirred with a stick. After repeated washings the shells and grosser parts were removed, and the pearls sought for at the bottom.

IX.—RECORD OF THE OCCURRENCE, NEW TO IRELAND, WITH NOTE OF A PECULIAR CONDITION OF THE VOLVOCINACEOUS ALGA STEPHANOSPHÆRA PLUVIALIS (COHN), AND OBSERVATIONS THEREON. By WILLIAM ARCHER. (Plate I.)

[Read before the Natural History Society of Dublin, May 6, 1864.]

THE discovery in Ireland of the very interesting and very beautiful, and apparently very rare organism, *Stephanosphæra pluvialis* (Cohn), would in itself alone be worthy of a record in the "Proceedings" of this Society. But inasmuch as, whilst I had a supply of this "Volvocine" in my possession, a remarkable phase or condition in its history, so far as I am aware not before observed in this form, though not without parallels elsewhere, presented itself to my notice, the value of that record becomes thereby in so far enhanced.

Spending an evening in the month of June last at Bray, I took a walk upon the "Head," promising myself indeed not much of interest (save the beautiful view) from its dry and rocky summit. The weather had lately been showery, and during the day a considerable quantity of rain had fallen. This had left behind small deposits of rain water in a few little hollows amongst the rocks. In one of these tiny pools, I perceived the water tinged with a beautiful light green colour. A few moments' inspection, even without a lens, was sufficient to indicate that this green hue was due to the presence of myriads of some "volvocinaceous" plant; and, with a lens, I soon perceived, by the annular and band-like green portions of the organisms, as they appeared under so low an amplification, alternately brought to view, that I had had the good fortune to encounter that seemingly rare organism *Stephanosphæra pluvialis* (Cohn), which Professor Cohn journeyed from Breslau to Hirschberg to see, and for the occurrence of which I can find hitherto but six localities, the present making a seventh. These are—Saltzburg, found by Werneck, Zambra, and von Frantzius; Hirschberg, in Silesia, by von Flotow and Cohn; summit of Heuscheur in Grafschaft Glatz, Silesia, by Cohn; Lapland, by Wichura; Schneeberg, Saxony, by Rabenhorst; Scotland, by Strethill Wright; and now lastly, at Bray Head, Ireland, by myself. It is very probably more common than these few localities might indicate, but these are at least all the records I can find.

As may be imagined, with no small amount of avidity I pocketed a supply of the treasure thus placed at my feet. The specimens so obtained afforded an opportunity in a great measure to follow out the statements made in Cohn's beautiful memoir,* with respect to the organization and development of this plant, such as the *macro-* and *microgonidia*, &c. As regards the latter, nothing further presented itself as to the purport or function of the bodies so called—like Cohn's own original specimens, they were formed, and disappeared.

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* Cohn, "Ueber eine neue Gattung aus der Familie der Volvocinen," in Siebold und Kölliker's "Zeitschrift für wissenschaftliche Zoologie," Band IV. (1852), p. 77, Tab. VI.; also "Annals of Nat. Hist.," 2nd Ser., vol. x., pp. 321 *et seqq.*, 401 *et seqq.*, Pl. VI.

This gathering was extremely free from other organisms. *Chlamydococcus pluvialis* did not present itself, thus, in that respect, unlike Cohn's original supply. A very few specimens, however, of *Gonium pectorale* occurred, but in so trifling numbers, that for a fortnight after I obtained the material, I do not believe I noticed half-a-dozen individuals, while the *Stephanosphæra* existed in myriads. The only examples of animal life to be noticed were a very few lively specimens of a noble rotiferon, a Brachionus.

However, before drawing attention to the peculiar condition alluded to, a very brief description of the organism in question may not be out of place, indeed such would perhaps be of advantage, if not essential (in the absence of a previous study of Professor Cohn's extended memoirs), to the appreciation of the confessedly imperfect observation which it is the object of this paper to communicate, and which indeed is the only new one I have to note, that has not been recorded by Cohn; and in doing so, I shall not enter into minute details beyond those which bear directly on the subject of this note.

The Family of Chlorospermatous Algæ, Volvocinaceæ, to which this plant belongs, is characterized by the individual green cells, being, during the greatest part of their life, active zoospore-like bodies, ciliated, either solitary or combined into definite groups, and either with a common enveloping membrane, until breaking up in carrying out vegetative developmental processes, or without a common membrane. With the exception of the genus Protococcus (Chlamydococcus) which is a single cell, the cells, though thus for the greater part of their existence associated into colonies, maintain their special physiological individuality; and collectively, at the same time, represent but one individual in relation to external objects. With these general characters, Stephanosphæra accords; that is to say, it consists of families of ciliated cells which originate from a single mother-cell through a series of divisions following a definite law; and when completed, the family possesses its own characteristic collective figure and organization. Here there are eight green masses of protoplasm—"primordial cells" (Cohn)—arranged circularly at regular intervals within a common hyaline membranous globe, so as to form an equatorial series. Each primordial cell is furnished with a pair of flagelliform cilia, which protrude through the hyaline globe, and, by their action in the surrounding water, cause the active revolution hither and thither of the aggregate family, that is, of the

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also Cohn and Wichura, "Ueber Stephanosphæra," Kais. Leop.-Car. Akademie der Naturforscher; Bonn, 1857. Of the latter memoir there is a short abstract in the "Quart. Journ. of Microscopical Science," vol. vi., p. 131.

Stephanosphæra-globe. Regarding the direction of the wreath or series of eight primordial cells as the *equator* of the globe, the rotating movement is effected round the axis uniting its *poles*, and its vigorous onward movement takes place in all possible directions.

Scarcely a more charming spectacle can be than a multitude of these elegant organisms vigorously rotating hither and thither, brightly green, and, under a peculiar light, glittering and flashing as they move, now showing a polar, now an equatorial view, or all intervening positions, rapidly passing and repassing, curving, and wheeling, and gyrating, crossing and recrossing each other, huddling and thronging sometimes in numbers together, again starting off, occasionally rotating without advancing or "resting on their oars,"—some larger and older, some smaller and younger, some showing young revolving Stephanosphæræ within, some developing "microgonidia,"—some in one stage, some in another. In respect of beauty and gracefulness, indeed, a number of the larger gently revolving emerald-studded globes of *Volvox globator*, executing their elegant revolutions, must, I think, carry off the palm; but their numbers, and the amazing energy of the gyrations of Stephanosphæra, the remarkable figure of the primordial cells, the differing sizes and curious appearances of the variously developed globes might cause some to give the latter the preference as a handsome object. Each, indeed, is certainly a charming sight!

To revert, however, to our subject. Notwithstanding that the structure and development of this organism have been copiously detailed in Cohn's cited elaborate memoirs, a brief *résumé* here will be necessary, in order to draw particular attention by and by to one or two points in its structure and organization, which I am disposed to think in some measure foreshadow the remarkable phase presently to be adverted to.

Stephanosphæra then consists, as we have seen, of a family or colony of eight green biciliated protoplasm-masses (primordial-cells), destitute of a proper cell-membrane, and arranged in a circle, more or less approximately and at even distances from one another, at the equator of a common enveloping hyaline rigid membranous sphere, composed of cellulose,—the "envelope-cell" ("Hüllzelle," Cohn). Though the normal form of the envelope-cell is spherical, I have occasionally but extremely rarely noticed such as possess, even when fully-grown, an elliptic, or ovate, or subtriangular, or sometimes even a figure-of-8 shape: such very rare and casual distortions do not seem at all to interfere with the otherwise normal growth and movements.

It is by the action in the surrounding water of the two flagelliform cilia belonging to each primordial cell, protruded directly through the envelope-cell, that the revolving and onward movement of the total organism is effected. The primordial cells present great variety of form—in the simplest condition globular, or nearly so. But in a fully grown Stephanosphæra when viewed equatorially, these primordial cells very frequently appear to be elongated in a direction toward the poles, and very often to a greater extent in one hemisphere than in the other—reaching sometimes almost to the pole in one, and leaving the other partially empty—that is an equatorial line in such cases would not cut the primordial cells into equal halves. These, whose general form in this condition in an old family, when viewed equatorially, may be said to be usually broadly fusiform or subelliptic, frequently present several filiform, often dichotomously ramified, more or less attenuated, colourless prolongations of the protoplasm, especially from their opposite ends, sometimes even tuft-like; these are occasionally very divergent laterally, or even project towards the centre of the envelope-cell. When the organism is quite mature, these colourless prolongations are mostly attached to the inner surface of the envelope, but never perforate it. When a Stephanosphæra-globe is seen in polar view, the outline of the primordial cells mostly appears somewhat acuminate towards the common envelope, and from such apex the pair of cilia take their origin. The primordial cells possess, immersed in their substance near the middle, two symmetrically disposed round bodies—called by Cohn nucleus-like vesicles, and said to possess an internal cavity.* To me, indeed, they appeared quite identical with the so-called "chlorophyll-vesicles" (Näg.) of other plants, to which indeed Cohn afterwards compares them.† Such may convey an idea of a perfect family—of a fully-grown Stephanosphæra.

Now, as to the developmental changes connected with propagation, the primordial cells, as described by Cohn, undergo three kind of changes. I shall first allude to that of "macrospores." The colourless prolongations of the primordial cells become drawn in, and the primordial cells themselves become rounded. A slight elongation of a primordial cell about to vegetate then takes place; it becomes gradually transversely constricted, and divided into two cells, which expand slightly from left to right; these two cells become divided each into two, those again into two, thus producing eight; the constrictions, however, taking place only in such directions that the young resultant group presents the form of a flattened spheroid, having somewhat the appearance, when either of the larger surfaces is towards the observer, of a *wheel.* These changes do not take place simultaneously in all the eight primordial cells of an old sphere, but are to be met with in different degrees of advancement. The further growth consists in the development of a delicate common membrane closely investing the young disk-like family, and in the centrifugal separation of the new primordial cells upon the completion of the several radial constrictions, and in the development of cilia. After escape into the water by the bursting of the original envelope-cell, the new envelope-cell of the young family, from being at first of a very considerably depressed figure, gradually expands in the polar direction until the spherical form is attained—the primordial cells meanwhile acquiring their mature appearance and structure. Thus each parent Stephanosphæra can normally give rise to eight young Stephanosphæræ, though families of but four cells occasionally, though rarely, occur (and still more rarely families of five, six, or seven), through arrested subdivisions of the parent primordial cells; whilst I have once or twice met with families of sixteen cells, arising from the "transition generations" (Näg.) being carried one stage further—that is, the (normally) eight cells each dividing once again before arriving at the fully formed or "mature stage" which may in similar manner be called the "permanent generation" (Näg.).

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* Loc. cit. ("Ueber eine neue Gattung aus der Familie der Volvocinen"), p. 83.
† Ibid., p. 97.

A second change connected with the propagation consists in the disassociation from the hyaline sphere, and the contraction of the primordial cells, as before, into rounded bodies; but in this instance this is followed by the formation round each of a special cellulose wall, through which protrude two cilia, by the agency of which these Chlamydomonas-like cells swim vigorously about, at first within the old parent globe, afterwards outside it, when they have made their escape by its destruction. Finally these Chlamydomonas-like bodies come to rest, lose their cilia, and assume a Protococcus-like appearance, or these Protococcus-like resting cells may apparently be formed without an intermediate motile Chlamydomonas-like state. These Protococcus-like cells have the power of increasing in size after their formation, and before any further development. Cohn and Wichura's researches have demonstrated the remarkable fact, that not only are these capable of revival upon being covered with water after complete and lengthened desiccation, but that such desiccation is absolutely necessary to induce further changes in the direction of the renewal of the Stephanosphæra-globe. A few hours after being remoistened the cell-contents of these resting-spores become divided into two, then into four (possibly sometimes eight) daughter-cells, the cellulose wall vanishing. These daughter-cells become biciliated, and presently one by one separate, and swim freely away as so many pear-shaped zoospores. Afterwards, coming to rest, they acquire a membrane which at first closely surrounds the contents; but presently expands, and, standing off, leaves the body of the primordial cell in the middle, which protrudes a pair of cilia through the wall, thus again assuming a Chlamydococcus-like appearance. The contents often in this stage present a number of hyaline frequently branched or forked projections in various directions from the outer protoplasmic layer (like those from the opposite ends of the primordial cells of the mature plant), and which touch the inner surface of the cellulose wall. But after an interval these Chlamydococcus-like structures begin to divide; if the protoplasmic processes exist, they are previously drawn in, and the primordial cells become rounded—a series of self-divisions sets in, similarly to those of the primordial cells of the perfect Stephanosphæra in the first mode of propagation, the cilia become lost, and the process is carried on until the same result is attained—that is, until from each Chlamydococcus-like body an eight-celled, in all respects characteristic, perfect Stephanosphæra is produced. I pass by the time required for these processes, as well as the hours of the day or night with which such developmental changes seem, as in other instances, mysteriously associated.

It may be well here momentarily to draw attention to an instance of the great similarity which often exists at certain stages of apparently essentially quite distinct organisms, and which occasionally more than ordinarily forces itself upon our attention.

I have mentioned that, when I first obtained the material, the presence of *Gonium pectorale* (Ehr.) was indicated by only a very few specimens indeed; but in about three weeks, in one of my bottles, this organism made its appearance in very considerable numbers, and they were remarkably fine and beautiful examples of this elegant form. In all respects they seemed to me to agree with the beautiful figures and description of Gonium given by Cohn.[*] I may remark that these specimens seemed to me considerably larger and finer than those one usually meets with, and more intensely green. In the material alluded to, which I possessed, numbers of the Gonium were to be found in the various stages of self-division figured by Cohn. But likewise a number of the specimens were present, as is often the case, from which some of the constituent cells of the tablets had been removed by some external force, or insufficiency of mutual coherence; and moreover, what appeared to be these isolated cells (or occasionally indeed dislocated in twos or in threes), were not a few of them to be seen actively urging themselves about in the surrounding water. Now, furthermore, some of the old globes of the Stephanosphæra occurred upon the slide, and some of these showed the primordial cells in the Chlamydomonas-like state, above adverted to, and these vigorously moving up and down within the old, often much collapsed, envelope-cell, while some of these had lost their normal number of eight, some indeed yet retaining only two or three. Now, at this point I was quite unable to distinguish one of these isolated motile bodies disassociated from a Gonium-tablet from an isolated motile body set free from an old Stephanosphæra-globe, both of which, after the emergence of the latter, moved freely about in company; nor apart from a knowledge of their origin could either be distinguished, I think, from so many examples of Chlamydomonas had they been present.

But from this I do not mean to argue more than a puzzling resemblance between the two. A single Gonium in the original material would have sufficed to give origin to the multitudes which afterwards

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[*] "Untersuchungen über die Entwickelungsgeschichte der mikroskopischen Algen und Pilze." Kaiser. Leopold.-Carol. Akademie der Naturforscher, Bonn, 1854, pag. 163. T. 18, Fig. 9, 14, 15, 16, 17.

made themselves apparent, conspicuous even to the naked eye, by their mass. I should be disposed to hold that here, as elsewhere, resemblance may by no means necessarily demonstrate identity; and although these isolated motile bodies, thus proceeding from Gonium and Stephanosphæra respectively, were so much alike as to be indistinguishable to the eye, for the present I doubt not there must have been between them some more subtle distinction, and that in the progress of development in their natural conditions, they would each have gone into their respective mature forms (and this notwithstanding what I have afterwards to advance), although Cohn did not see (nor have I noticed) the isolated cells of Gonium, but only those still undisturbedly *in situ*, become segmented, and directly form a new young Gonium-tablet, whilst on the other hand, as has been stated, it can be demonstrated by direct observation that in Stephanosphæra the single Chlamydomonas-like primordial cell eventually produces a new Stephanosphæra-globe. Cohn neither in his first, nor in his and Wichura's subsequent memoir on Stephanosphæra, makes any allusion to any development of Gonium making its appearance in the material which formed the subject of his earlier observations on the former organism; but I find that he incidentally mentions, in his memoir on Gonium* that on one occasion at least a copious development of this latter organism took place in a vessel in which he had been cultivating Stephanosphæra; and that in so great quantities, that the water resembled a green mucus, and in each drop thousands abounded. This is then at least a possibly noteworthy coincidence, and the circumstance, *quantum valeat*, is perhaps deserving of this cursory record.

A third developmental change of the primordial cells of Stephanosphæra, connected doubtless in some way with propagation, is that which results in the formation of "microgonidia." Their development is at first like that of the "macrogonidia"—that is, the division of the primordial cells into two, into four, into eight, but not stopping here, but again dividing into sixteen, and so on, and finally into an innumerable number of minute elongate fusiform quadriciliate cellules—the "microgonidia." These do not at any stage secrete an envelope-cell, but remain crowded together within the original envelope-cell, inside of which they actively move hither and thither in an amazingly rapid and energetic way, than which there is scarcely any more astonishing sight; these finally escape from the old envelope-cell by its rupture; and losing their cilia, coming to rest, and assuming a reddish colour, become developed by a series of self-divisions, and formation of special walls, into structures somewhat like in *form* (and I believe in that only) to Botryocystis, or to Kützing's Microcystis or Polycystis; of these any further development is unknown. It has been supposed that these microgonidia, as in Volvox, may be perhaps looked upon as spermatozoids, but no such function seems to be confirmed by actual observation. It is, perhaps, more probable that they are homologous rather with the microgonidia of Hydrodictyon, a plant otherwise presenting so very many affinities with Stephanosphæra. Pringsheim has shown that in Hydrodictyon the microgonidia are really structures intended themselves eventually to reproduce the plant in a future season.*

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* Op. cit., p. 169.

It will be seen that Stephanosphæra differs from its well-established fellow-genera in Volvocinaceæ—not to descend to minor but important details of structure and development—from Volvox, in having the zoospores or primordial cells eight only, and at the equator, not numerous all over the periphery of a sphere; from Pandorina, in having eight only at the equator, not sixteen or thirty-two, arranged in tiers; from Gonium, in having the eight primordial cells within a common spherical envelope, not sixteen, each having a thick coat, cohering by certain points of their surface into a tablet; and from Protococcus (Chlamydococcus), by the cells not being solitary.

Having thus endeavoured to convey an idea of the nature and appearance, of the structure and development of Stephanosphæra, a necessary preliminary to the short and very imperfect note I have to offer, I now proceed to draw attention to the peculiar condition which it is meant to record.

I have mentioned that, at a certain time, the primordial cells, in this organism, having become removed from the inner surface of the common hyaline sphere (envelope-cell) and having acquired a rounded figure, may proceed thereupon to further developmental changes, with the object of directly producing each a new young globe, or may assume temporarily either an intervening Chlamydomonas-like or a Protococcus-like condition. Now, in certain of my specimens the development of the primordial cells had advanced in this direction so far as the drawing in of the protoplasmic prolongations, and the assumption of a rounded form, in which condition they sometimes persist for some time when long in the house in a secluded position, the globes still revolving vigorously and actively. But having isolated a considerable number of these examples on a growing-slide, and on my return to them some hours afterwards, I was very greatly astonished to find the slide to a considerable extent crowded by a number of what appeared to me to be Amœbæ of some undescribed species, and these in active movement, gliding about and crossing each other in every direction. These were certainly not to be seen when I last looked at the slide, and the phenomenon was beyond measure puzzling. I therefore rigidly examined them. It will readily be believed that my astonishment was beyond measure great, upon shortly beyond all question identifying these vigorously active Amœba-like bodies with the just previously absolutely quiescent primordial cells of the Stephanosphæra—nay more, in watching the transformation of the latter themselves into the reptant amœboid bodies, putting a parasitic development wholly out of the question: it will readily be believed, I say, that my astonishment was beyond measure great, in actually witnessing with my own eyes this, at first sight, sufficiently startling phenomenon. What! a plant, an undoubted true chlorophyll-containing, by cellulose externally bounded, Alga, become metamorphosed into an animal! For my part, indeed, even after witnessing the wonderful change now mentioned, I could not acquiesce in such an assumption; and so far as I can see, in my humble judgment, those who might be disposed thus to understand it would greatly misinterpret the phenomenon.

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* "Berichte der Akademie der Wissenschaften zu Berlin," 1860; "Ann. des Sciences Naturelles," IV^{me}. Ser., t. xiv., p. 52; "Quart. Journ. of Mic. Sci.," N. S., vol. ii., p. 54.

I shall try to describe these remarkable bodies more fully.

I have spoken of the primordial cells of these examples having become retracted from the inner wall of the hyaline sphere, and having acquired a rounded form within it, as if possibly about to undergo either the ordinary process of self-division, or it might be the Protococcoid or the Chlamydomonas-like developmental condition before alluded to, the movement of the globe itself having ceased. But, upon a closer examination of certain of these, there was to be seen a gentle hyaline convexity or expansion gradually being extended from the green margin of the primordial cell, and again slowly drawn in, whereupon another similar projection took origin close beside the place where the first had vanished. This again receded, to be followed perhaps by another in the same or nearly the same situation as the first, or at all events near thereto (Plate I., Fig. 3). Presently the extension and withdrawal of these hyaline prolongations became more frequent and vigorous, while they appeared to be chiefly confined to one hemisphere. Afterwards the mass became somewhat elongated, the hyaline projections more lobose and more changeable, and finally the primordial cell assumed somewhat the *outward* characters figured for *Amœba limax* (Plate I., Figs. 4, 5, 6). The general contour of the so far changed primordial cell, supposing it at rest, might now be described as broadly clavate or pyriform, the narrower end tapering very considerably, and bluntly pointed. From the considerably expanded upper end only, the lobate pseudopod-like extensions were projected; and of these generally not more than two or three existed at one time, so that this margin mostly thus presented a trifid or bifid outline. The narrow end seemed to be nearly if not quite rigid; at least, neither from it nor from the sides were any of the pseudopod-like extensions put forth, whilst the narrow extremity itself seemed to possess somewhat of a slightly granulated appearance. All traces of the conspicuous pair of "chlorophyll-vesicles" (for as perfectly homologous with the bodies *so-called* in other algæ I regard them) had vanished—the green contents, keeping their colour, had become more decidedly granular; the granules, which were very crowded and abundant, and of varying sizes, the variations however taking place within very narrow limits, were apparently quite free from each other, and with the alternating movements of the lobate extensions became rolled onward, I might almost say, just as so much shot (of somewhat differing sizes) in a caoutchouc bag might be, supposing it endowed with a like innate automatic mobility. I could find no trace of a nucleus, nor of a contractile vesicle, as in a true Amœba; however, if such really existed, I fancy the extreme density and abundance of the opaque green granular contents would have prevented their being noticed; and I may add, there was not a single instance of any foreign organic body to be seen in their substance. But, to borrow the terms made use of for a true Amœba, the "endosarc" and "ectosarc" (so to speak) were abundantly well differentiated. The latter, I apprehend, more correctly regarded as actually the so-called "primordial utricle," was hyaline, presenting a border of nearly equal width all round, and at all parts of the external margin, except at the attenuated extremity, was very clearly and sharply defined; at the narrow mostly bluntly pointed extremity, as I have already said, the margin presented a somewhat granular appearance, or at least not a smoothly defined outline. Beyond the limits of the inner boundary of the hyaline border, the contained green granules did not infringe, no matter how energetic or changeable the movements of the pseudopodal processes (Figs. 4, 5, 6).

The changes described did not take place by any means simultaneously in all the eight primordial cells of any Stephanosphæra-globe; but while one, perhaps, might have attained the complete amœboid state, another might be still in the simple condition of a rounded uncoated cell, without as yet any apparent intention to undergo the wonderful change described, whilst several of the others might exhibit various intervening phases between both conditions (Fig. 3). During the changes of the primordial cells described, the old common hyaline envelope-cell of the Stephanosphæra became collapsed, and burst, or it may be more or less dissolved, and from its trammels the now reptant amœboid primordial cells, by means of what were decidedly their own automatic movements, by degrees mostly all succeeded in becoming one by one wholly emancipated.

A pseudopod was projected from the broader rounded anterior extremity of one of the so greatly modified primordial cells, not slowly, not as it were hesitatingly, but with great vigour and considerable rapidity. The hyaline lobose expansions were generally extended to about a quarter or a third of the whole length of the total amœboid body; and no sooner had one begun to be projected than a rapid flow of the granules at once took place into it, but still not infringing on the hyaline border. This was scarcely accomplished, when another similar lobose expansion was projected from the opposite side of the frontal or anterior margin, and thus, by drawing into it a similar influx of the granular contents, rapidly obliterating the former. One, two, or three (rarely more) of these lobose expansions, were mostly evident at a time, but, of course, in various degrees of expansion and retraction, an influx of the granules taking place into that most recently formed at the expense of the others, the newest advancing always onwards beyond the others, and thus was a rapid reptant movement executed (Figs. 4, 5, 6). Their onward progress was often made in a tolerably straight line; but, of course, curves and sweeps, sometimes even somewhat abrupt, were effected, the broader frontal margin being always carried in advance, the attenuated extremity always at the posterior.

In this way these amœboid bodies travelled over the field with quite surprising rapidity, crossing and recrossing each other in all directions. Under a low power, insufficient at first sight to show the amœboid or "rhizopodous" mode of progression, these reptant bodies might possibly have momentarily called to mind so many minute green Planariæ, their crawling movement partook so much of a regular gliding character.

So rapid was the action of the pseudopodal extensions and that of the onward flow of the general mass, and so energetic was the locomotive power of these remarkable amœboid bodies, that, not unfrequently, one of these primordial cells which had fully assumed this condition, prevented by some cause or other from becoming wholly extricated from the old Stephanosphæra-globe, was actually able to drag about along with it (like hermit-crab and his whelk-shell) not only the old envelope-cell, but the perhaps still therein contained seven other more or less changed primordial cells; and, all the while, apparently not much retarded nor materially incommoded by the incumbrance!

It may be worth while, *en passant*, to note the analogy in the differentiation of the extremities of these amœboid bodies with that of Dr. Wallich's lately described *Amœba villosa*,*—the tapering, faintly granulate, posterior extremity seeming to correspond to the villous rounded organ in the actual Amœba, described and figured by Dr. Wallich. This appears at least a curious point in common. In both the narrowed extremity was always posterior, the pseudopods always being given off from the opposite or anterior portion, and in both, hence, the onward progression was more direct than in most similar bodies, as well as more rapid; though, so far as I can see, if we could imagine one of Dr. Wallich's Amœbæ pitted against one of my Amœbiform bodies, the former, I fancy, would have been beaten in the race!

I have indeed never seen any actual Amœbæ, nor do I imagine any body else, whose movements were so rapid, and power of locomotion so vigorous, as those of these amœboid bodies of Stephanosphæra. One might almost fancifully imagine them endowed with a will, and in an evident hurry to get somewhere, but unfortunately with a bad memory, and always forgetting what their destination should be, or with what object they set out; or, as if they each had lost something, and all were laboriously and diligently making the best use of their locomotive powers, under the hallucination that there might be a hope of fortuitously stumbling upon it unawares!

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* "Ann. Nat. Hist.," 1863, vol. xi., 2nd Ser., pp. 287, *et seqq.*

After having, I might almost say, *disported* themselves in the manner described for a period from about twenty-four to thirty-six hours, their locomotive powers began to wane, and their energy and agility to flag; presently their onward progress became gradually slower and slower, and the lobose pseudopodal processes alternated more and more lazily and languidly, until, by degrees becoming more and more inert, they finally one by one became altogether still. At this point, I greatly regret, my observations upon this marvellous condition also came to an end. Just as they had all or nearly all acquired a rotund protococcoid figure, having been obliged to leave them, the slide, upon which they were, became dried up during my absence, nor could I find at any other period any more of these Stephanosphæræ undergoing this remarkable phase. But, from finding in the bottle whence these were taken numbers of the protococcoid condition, it is probable, had these special examples not been interrupted or thwarted in their development, that they too would have passed from the amœboid to the protococcoid condition.

I presume I need not here delay by urging the now, I believe, universally acknowledged claims of Stephanosphæra, and of the remaining Volvocinaceæ, to rank in the vegetable kingdom. Their whole affinities are with certain algæ of the Chlorospermatous class. *Hydrodictyon utriculatum*, an indubitable alga (not found in Ireland), presents, at every step of its history, points in common with Stephanosphæra, and both Hydrodictyon and the Volvocinaceæ are closely related to Pediastreæ, and to the genus Polyedrium (Näg.), &c., &c. So intimate is this affinity, that I conceive those who would now refer Volvocinaceæ to the animal kingdom, would be compelled to include Hydrodictyon and Pediastreæ in the transfer, and, so far as I could see, by an inevitable sequence, the whole of the Confervoideæ (Chlorospermeæ) likewise; which, I need hardly remark, would be simply absurd.

There was a time when locomotion effected by the agency of cilia was regarded as an infusorial or animal characteristic; now it is well known that very many undoubted vegetables, in some phase of their existence, are provided with these appendages. There was a time when the existence of the so-called "eye-speck" was regarded as a peculiarly animal indication; it is now well known that the active spores of many undoubted algæ possess this red dot; nay, some unicellular plants, whose whole life seems to be passed in a still condition, very beautifully exhibit this characteristic. There was a time when the presence of a "contractile vesicle" was looked upon as an animal characteristic; but this too shows itself in plants; for instance, Gonium. There was a time when contractility, though merely indicating itself by a capacity of altering relative length and breadth, or of taking and recovering an external impression, was regarded as purely an animal mark; but many vegetable cells (zoospores) possess it. There was a time when the presence of starch was regarded as a strictly vegetable characteristic; but this product has been found in the animal kingdom; for instance, Amœba.

And yet, so far as I know, there are but few of the organisms exhibiting any of these puzzling or apparently contradictory phases just alluded to, which the most experienced observers have lately, *merely on that account*, thought fit to remove in their conceptions from the one kingdom to the other. I pass by the futile and uncalled-for efforts of some to form an intermediate kingdom between the animal and the vegetable kingdom. And surely, then, it appears to me, if certain organisms in the one kingdom in the course of their life-history temporarily undergo or simulate those phases which I have alluded to, more especially characteristic of some organisms belonging to the other kingdom, it is, perhaps, at least *not more* surprising, after all, that a strictly vegetable cell should assume temporarily an amœboid condition. And it appears to me that not one of these contradictory temporary phases seems in the least to prove the actual and essential convertibility of an organism belonging to one kingdom into the other. It is quite true, indeed, that any one looking at one of my amœboid bodies for the first time, and knowing nothing of its origin, could hardly but believe that it was a true Amœba, but so peculiar and distinct, even at first sight, as that it could not be mistaken (so far as I can see) for any described Amœba, but would naturally have been looked upon as a new species. But all misconception as to these points becomes altogether done away with, and any such assumptions become wholly set aside, when we *know* that it was no Amœba at all, but only an amœboid state of the vegetable Stephanosphæra; and had it been so described by any one as a new Amœba in ignorance of its nature, it is probable that some time or other, as the result of subsequent observation, it would, as a species, have shared the fate of many of Ehrenberg's *quondam* Infusoria, now known to be zoospores of algæ, &c.

But, what the special import of this curious and remarkable exceptional temporary condition in Stephanosphæra, which I have sought to describe, might be, I cannot dare to take upon myself to conjecture. However, if we seek for and find precedents or examples in the vegetable cell, though some of them may be evinced even in a much less marked degree, of that peculiar contractility exhibited by this organism, while it would not detract from nor diminish the marvel, it would at least lessen the surprise natural on at first witnessing or considering the phenomenon.

Let us look back, then, in the first place, for a moment, to one or two conditions of Stephanosphæra itself, and I think we shall find that a similar phenomenon presents itself to that forming the subject of this paper, but in a far less marked, therefore at first sight in a far less notable and surprising degree.

Let us refer to the typal full-grown Stephanosphæra;* and, as has been stated, we frequently find the protoplasm of the primordial cells drawn out at each extremity into several filiform, somewhat branched, colourless prolongations, mostly in contact with the inner surface of the hyaline envelope cell. We find, preparatory to the primordial cells undergoing the Protococcoid or other intermediate developmental condition, that these protoplasmic elongations are drawn in. Now, except as regards the length of time occupied in the process, I do not see any essential difference between this and the action of the pseudopodal processes in my amœboid bodies—the one, in the ordinary course of its existence, takes hours to project and again to withdraw what, with equal right, may be called "pseudopodal processes," while in the other the act was momentary. It is true that, in describing these protoplasmic prolongations in the primordial cells, Cohn and Wichura* suggest that these in the young Stephanosphæra adhere, here and there, at certain points, to the inner surface of the envelope cell; and that during the expansion of the latter, as it approaches maturity, these prolongations of the protoplasm may thereby be gradually drawn out. But one frequently sees some Stephanosphæræ in which the primordial cells are not thus drawn out into these slender prolongations; indeed, I find them constantly so when kept some time in the house in semi-obscurity, and therefore these do not seem to be due to a structural peculiarity, but to the innate power of the primordial cells to put them forth. Nor, again, when present, do they all seem to reach the inner surface of the envelope cell, and some even finely drawn out appear to project obliquely inwardly. Similar extensions of the protoplasm are, in other stages of development of Stephanosphæra, to be seen figured in Cohn and Wichura's memoir,† which in the course of development are again drawn in; so also in Chlamydococcus. Now, it seems to me that this ordinary behaviour of the primordial cells in the development of this organism, and the action of my rapidly reptant amœboid bodies (precisely the same primordial cells), are manifestations of one and the same phenomenon, differing only in the degree of intensity with which they are evinced.

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* Cohn., l. c., Plate VI., 2, 4, 5, 6, 7.

It may be said that the primordial cells of the mature plant do not change place within the envelope-cell; but there are circumstances, even though the force were more energetic than it at all can be, which prevent this. The pair of flagelliform cilia projecting through the extremely minute openings in the wall of the primordial cell into the water, and the majority of the protoplasmic prolongations reaching to contact with its inner surface, where they doubtless for a time adhere, tend to suspend the primordial cell in its place. But even when these are not fully extended, and besides the slowness and comparative feebleness of the process, the prolongations existing at opposite ends simultaneously and the contents being of a compact and comparatively firm character, not loose and disintegrated as afterwards, as evinced by the constancy in position of the two "chlorophyll-vesicles," there is no flow in any direction of the contents, nor any reptant motion. There is, I think, to some degree, a certain amount of foreshadowing, as it were, of the differentiation of the extremities, so conspicuous in my amœboid bodies, in the ordinary primordial cells: it will be noticed that these are often far more copiously drawn out into the described filamentous prolongations at one end than at the other, which is more attenuated; and one end of each of the primordial cells is often drawn much more into one hemisphere of the globe than the other.

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* "Ueber Stephænosphæra," loc. cit., p. 16.

† Ibid., Tab. B, 12, *a*, *b*, *c*.

Now, the foregoing remarkable considerations seem to have excited comparatively little notice; and it is only when such characteristics are evinced so forcibly as that the primordial cells crawl rhizopod-like about, that it strikes us with wonder. The amœboid bodies described become propelled constantly in one direction, because the pseudopodal processes are given off only at one extremity, and the influx of the granular substance of the mass is of course obliged to follow in that direction.

But the assumption by the primordial cells of Stephanosphæra of an amœboid condition is not without a parallel in another volvocinaceous alga. Dr. Hicks has described an amœboid condition of the "zoospores" of the far more familiar *Volvox globator.* * In this organism some of the gonidia increase in size, become colourless; but, containing some brown or reddish particles, become detached from the circumference of the sphere, and acquire the power of protruding and retracting at various points the outer protoplasmic layer (primordial utricle), just like so many true Amœbæ. By this power they glide along the inner surface of the sphere. Dr. Hicks enters into some arguments to prove that these are really the modified zoospores or gonidia of the Volvox, and not true Amœbæ which have entered the Volvox, and have devoured each a zoospore equal in size to itself, and then digested it. His arguments, indeed, that it is an actual change of the gonidium itself, seem irrefutable.

But the amœboid bodies of Volvox differ in some particulars from those of Stephanosphæra. In the latter they do not become colourless, as in the former, but retain, as has been stated, their green contents, but in a more disintegrated and loosely granular condition; they do not contain any reddish particles, as in the case of Volvox. In the case of Stephanosphæra (as has been stated), the extremities of the amœboid bodies are definitely distinguishable as an anterior and a posterior end, from the former only of which are the pseudopodal processes protruded, whilst in the amœboid bodies of Volvox there is apparently no such differentiation of the ends, and the processes are put forth in any direction. Dr. Hicks has not seen the amœboid bodies of Volvox to leave the old sphere and move about in a free condition. In the amœboid bodies of Stephanosphæra I have not seen any indication of a further change into the oval ciliated bodies described by Dr. Hicks.

In his very interesting paper alluded to, the same author cites two other cases of vegetable amæboid bodies observed by him. He describes a change of the cell-contents of the radicles of a moss into an amœboid

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* "Quart. Journ. of Microscopical Science," vol. viii., N. S.; "Transactions of the Microscopical Society of London," p. 99, Pl. VI. (1860), and vol. ii., N. S., p. 96 (1862).

state: the contents of certain cells became detached from the cell-wall and collected into one or more ovoid masses, which sometimes became segmented; their colour became temporarily changed to a reddish or reddish-brown, presently they lost colour, except a few reddish granules, as in Volvox, and became essentially amœboid, travelling up and down the cells. Shortly they withdrew the pseudopodal processes, and became rounded and ciliated all over, beyond which Dr. Hicks' interesting observations were not extended. To these cases Dr. Hicks adds another, that of the amœboid transformation of the "gonidia" of a moss. The "primordial utricle" or outer protoplasmic layer became enlarged, at first feebly sending out short and rounded lobose processes. Afterwards the green contents vanished, and the whole body became colourless, containing a few reddish-brown granules and same vacuoles; the processes became more elongate, and finally quite amœboid, moving freely about.

To the foregoing may be doubtless added the case referred to by Hofmeister,* in giving an account of the structure of the "spore-mother-cell" of a particular moss, of which he writes:—"The cell-contents, which are plainly surrounded by a thin layer of soft matter, very like a delicate membrane, swell slightly, or not at all; they (the cell-contents) lie freely in the inner cavity of the cell, in the form of a closed vesicle, surrounded by watery fluid. Individual points of the primordial utricle sometimes exhibit slow expansions and retractions, similar to those of the inferior animals; for instance, the smaller Amœbæ" . . . . This is most probably a case in point, although the cell-contents, still enclosed within the parent-membrane, in the instance thus recorded, were not at liberty to move.

The only other published record of what truly seems an actual case in point, which I have met with, of a locomotive power due to an amœboid motile contractility in an *undoubted* vegetable cell, is that by Schenk.† This author describes the nucleated colourless uniciliated zoospores of *Rhizidium intestinum* (a plant destitute of chlorophyll), as capable, during certain intervals, of moving about by the protrusion of amœboid processes, each thus generally presenting a constantly changing two, three, four, or five-lobed figure, the lobes projecting in various directions, or for a time without lobes, and drawn out and very slender, whilst the internal movement of the granules was exactly that of an Amœba. After some alternations of a still and a slowly contractile condition, and of an active movement by aid of the cilium with which each is provided, the zoospore finally assumes an elliptic figure, comes to rest, loses the cilium, and developes (*more suo*) into a new young Rhizidium plant.

Carter too speaks of a condition apparently "rhizopodous" of the contents of the cells of *Spirogyra crassa*;‡ but he has lately seen fit to alter his views. He now thinks that this was not really due to an amœboid condition of the contents of the cell itself, but rather, if I understand his remarks aright, to a true rhizopod, whose germ had been included by some means within the mass of protoplasm, or that it was a development of the parasitic plant, *Chytridium endogenum* (A. Br.). Judging from the analogy of the other cases cited, it does seem indeed not improbable that it may have been likewise an example of an amœboid condition of the protoplasm, though it seems possible that this, as well as the development of Braun's *Chytridium endogenum*, may have been witnessed by him. Unfortunately his paper, which is published merely in abstract from the "Journal of the Bombay Branch of the Royal Asiatic Society," is without illustrations; and it is difficult to gain an exact idea of what the phenomena really were, which it is intended to record. But he seems to describe a truly rhizopodous state of the so-called "monads" (zoospores) evolved from the Chytridium, which may really be a case in point, and which at least remind us of the phenomena described by Schenk as regards the zoospores in the closely related parasitic plant, *Rhizidium intestinum*, before alluded to. Carter likewise seems to speak of a "polymorphous" condition of the cell-contents in the Characeæ;* but the plants under examination by him, so far as I can venture to judge, seem to have been in an abnormal and decaying condition, and had apparently become the prey of some parasites—nay, he speaks himself† of the *hole* by which the parasite might have found its way into the infested plant. That the whole was in an unhealthy condition I venture to think, from his speaking of the occurrence of a transparent mucus, with a great development of *Bacterium termo* (Duj.), (mucus and Bacterium taken together being *Zooglœa termo*, Cohn), and always indicative of the decay of the mass amongst which it makes its appearance. Therefore I should venture to exclude any of the conditions forming the subject of Carter's observations on Characeæ from the same category as that of Stephanosphæra, Volvox, Rhizidium, &c., forming the subject of this paper; that is, I should imagine, they do not form an example of an amœboid condition of vegetable protoplasm, but are actually foreign parasitic growths, with the exception possibly (as above indicated) of the zoospores of the Chytridium.

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* Hofmeister "On the Germination, Development, and Fructification of the Higher Cryptogamia" (Ray Society's Publication for 1862), pp. 162–3.

† "Ueber das Vorkommen contractiler Zellen im Pflanzenreiche." Würzburg, 1858.

‡ "Annals of Nat. Hist.," 2nd Ser., vol. xix., p. 259.

I have mentioned the case of the zoospores of Rhizidium as the only other instance, besides Dr. Hicks', I had found recorded of a strictly amœboid condition of an *undoubted* vegetable cell. For, as by so experienced and masterly an observer as Professor de Bary the hitherto so-called Myxogastric Fungi have been accounted as belonging to the Animal Kingdom, the amœboid condition of these organisms cannot be quoted as occurring in "*undoubted*" plants;‡ but that that group of organisms, while their reproduction appears to be vegetable, should present an intervening, though more prolonged amœba-like condition, seems, I should venture to suppose, no more to demonstrate their animal nature, than do the temporary amœboid states of Stephanosphæra, of Volvox, of the Moss, or of Rhizidium, prove that they belong to the Animal Kingdom, seeing, as is well known, that all their analogies and affinities are with plants, and their true position cannot for a moment be doubted. Professor de Bary, while admitting the force of certain analogies presented by unquestionable plants, contends that in his "Mycetozoa" (Myxogastres) the free power of motion occurs, with a greater intensity, and persists through a greater section of their developmental processes, than is at all approached by any plant.* But at least the free power of motion, externally of the enveloping protoplasmic mass, and internally of the thereby induced flowing granular contents, and the consequently reptantly locomotive power of the whole could not occur in greater intensity nor more energetically in any "*Mycetozoon*," nor in any true "*Amœba*," than in the thus remarkably temporarily modified primordial cells of Stephanosphæra. Had, therefore, de Bary been aware of this condition of the latter, or of those of Volvox and the Moss, put forward by Hicks, I venture to think that perhaps he would not have insisted so strongly on the extreme view he has taken as regards the Myxogastres. That within the substance of the protoplasmic mass of the Myxogastres foreign organic bodies have been found, is beyond question; these, however, have been confined, I believe, to the spores of the plant (?) itself. As to the significancy of the fact, however, and into the discussions which have taken place thereon, I cannot dare to enter.†

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* "Observations on the Development of Gonidia from the Cell-contents of Characeæ," &c. (Ann. Nat. Hist., 2nd Ser., vol. xvi., p. 1); also, "Further Observations on the Development of Gonidia from the Cell-contents of Characeæ" (Ann. Nat. Hist., 2nd Ser., vol. xviii., p. 101).

† "Ann. Nat. Hist.," vol. xvi., p. 21.

‡ De Bary, "Die Mycetozoen," in Siebold and Kölliker's "Zeitschrift für wissenschaftliche Zoologie," Band X., pag. 88.

The analogy of the phenomenon here described in Stephanosphæra with that which is known of the development of the Gregarinida will be sufficiently apparent,—the so-called "pseudo-navicellæ," like my "primordial cells" of the Stephanosphæra, upon leaving the cyst within which they were generated, passing into a temporary amœboid condition; and though this indeed may be nothing more than an analogy, yet is it decidedly still worth noticing. Nor has the similar analogy existing between the Myxogastres (Mycetozoa, de Bary) and the Gregarinida been failed to be urged by de Bary in argument for the validity of his conclusions in regard to the animal nature of the former.‡ But the arguments drawn from this analogy could not at least be considered equally valid, if similarly applied in both instances; for, if this analogy with Gregarinida were admitted to have equal force in the Volvocinaceæ (here apparently exceptional, and less permanent, as the peculiar condition which gives rise to it may be) to that which de Bary considers it has and lays claim to for it in Myxogastres, its application must, I think, lead to deductions, as regards the chlorospermatous Algæ in general, so sweeping and comprehensive as to be totally unreasonable and altogether untenable.

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* Loc. cit., p. 166.

† *See* ex. gr.: Hoffmann, in "Botanische Zeitung," 1859, p. 202; Wigand, in Pringsheim's "Jahrbücher für wiss. Botanik," Band III., pag. 1; Cienkowski, ibid., Band III., pag. 325; De Bary, in "Flora," 1862, pp. 264, *et seqq.*

‡ "Flora," 1862, p. 303.

I might, perhaps, have referred to one or two other cases, *possibly* similar to those I have cited of an amœboid condition of the protoplasm within the vegetable cell. I say *possibly* similar; for, as the records are not sufficiently copious or exact, it does not seem at all certain whether such may be really cases in point, or may be instances of the actual ingress from without of a true animal. Cienskowski's observations* show that his *Monas parasitica* can make its way into a vegetable cell from without, as he witnessed it, through the cell-wall, within which it puts on an amœboid condition. I venture to imagine that it may be possible that some of Carter's cases may have been similar to that described by Cienskowski, although I am not aware that the observations of the latter have been confirmed by any other observer.

In case observers should in future meet with vegetable cells showing Amœba-like structures within, special attention should therefore be paid to this point, as to whether they are foreign intruding parasites, or are really due to any phase or change of condition of the protoplasm of the vegetable cell itself. There cannot be a question, however, as to the accuracy of Dr. Hicks' and Professor Schenk's observations, and that a parasite had nothing to do with the phenomena they describe. And that the primordial cells themselves of Stephanosphæra actually became temporarily changed as I have described, and not that they each became the choice morsel of a *burglarious* Amœba, is likewise beyond the faintest shadow of a doubt.

But, leaving out of view the Myxogastres, as well as any such cases possibly but only conjecturally similar to the authenticated instances here cited, I fancy it would not be difficult to find further examples, far less pronounced and far less striking, it is true, than in Stephanosphæra, Volvox, Moss, or Rhizidium, of that automatic contractility which in these established cases makes itself so remarkable, as even to present phenomena characteristic of a true Rhizopod.

Let us take a look, for instance, at the figures of the zoospore of Œdogonium at the moment of its escape from the parent-cell.† The contents of a cell destined to become a zoospore become withdrawn from the cell-wall, and somewhat contracted into a sub-elliptic figure; at one side there makes itself apparent a pale space, which is the place whence afterwards is to originate a crown of cilia. The parent cell-wall splits, and the zoospore makes its egress, often through a space actually too small to allow it to pass without a modification of its form; and this, in such instances, is really what takes place. It may be said that its motions are assisted by the cilia; but they have not yet begun to play, nor, if they had, could they cause that alteration of figure, "like that of a Euglena, from second to second," of which Cohn speaks.[*] There can, I think, be no doubt but that the zoospore here, in such accidentally difficult cases, is mainly assisted in its birth by its own innate contractility. Nägeli,[†] and, apparently following him, Vaupell,[‡] seem to urge that an exosmotic action operates upon the young zoospore, inducing the phenomena described. Cohn likewise,[§] in such cases (speaking of the zoospores of Vaucheria and Hydrodictyon), where the so-called primordial utricle (outer protoplasmic layer) presents contractions and expansions, seems to have arrived at the conclusion that such alterations of figure are wholly due to the taking up and withdrawal of water, and not to any special inherent contractility. The very interesting experiments upon Spirogyra, Closterium, &c., which Cohn describes seem to prove only that by the alternate absorption and withdrawal of water the cell-contents become contracted or expanded as a whole, that is, become alternately changed in bulk and density; but it does not to me appear that such experiments call forth anything like "rhizopodous" phenomena, such as those described in this Paper, nor will the results of such experiments account for them. The former (that is, automatic contractility) is, I venture to believe, far more likely to be the true solution. Many other similar instances in zoospores (for instance, Vaucheria), as is well known, might be here cited. Yet in his elaborate memoir on *Protococcus pluvialis* (Kütz.),[||] published previously, the latter observer seems to dwell upon the similarity of the contractile phenomena presented by the primordial utricle of that remarkable organism to those shown by Euglena and Astasia; and he bases thereupon certain comparisons of the vegetable protoplasm to that of the animal, leading him to the conclusion that these are quite analogous, correctly regarding (as I conceive) *Protococcus pluvialis* as a plant, and assuming Euglena to be an animal. However, his own very interesting observations on Euglena,[**] as well as those of others, seem rather to point to the conclusion that this puzzling organism is really a phase of a plant. Hence, as I conceive, it seems to have needed such observations as those of Dr. Hicks, and that on Stephanosphæra here recorded—that is to say, evidence of automatic rhizopodous movements in undoubted plants—to complete the proof of the similarity of the animal and vegetable protoplasm.

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* Cienskowski, "Die Pseudogonidien," in Pringsheim's "Jahrbücher für wissenschaftliche Botanik;" Band I., 1857, pag. 371, t. xxiv., 2, 3, 4.

† See the following, *e. g.*: Cohn, "Untersuchungen über die mikroskopischen Algen und Pilze," t. 20, Fig. 1, 2, 22, 23; Pringsheim's "Jahrbücher für wissenschaftliche Botanik," Band I., 1857, t. i., Fig. 13, 14, 15; Vaupell, "Iagttagelser over Befrugtningen hos en Art af Slægten Oedogonium," Fig. 4, 11, 12.

Again, in our search for analogous cases, as regards cells which are not zoospores, let us refer to the figures of my *Mesotænium mirificum*, which I brought before the Society, during last session.* Here the contents of a single Mesotænium-cell escape therefrom without conjugation through a lateral or terminal or variously disposed opening, effected by the raising up of a lid- or valve-like portion of the membrane of the parent cell. During this act, the emerging contents are often much constricted by reason of the narrowness of the aperture by which they make an exit, and after emergence the mass becomes rounded. Now, Mesotænium is a plant which does not generate zoospores, and whose developmental stages are regarded as quiescent, yet here the protoplasmic mass, wonderful as it may (at first sight) appear, actually comes forth into freedom, through an opening very considerably smaller than even the narrowest diameter of the former. This paradox is solved by witnessing the phenomenon:—a lobe-like extension, I might write a pseudopodal process, is protruded through the opening; a portion of the contents is slowly drawn after, thus relieving the mass behind, which contracts upon itself; and the gradual extension and expansion of the portion outside the old membrane by degrees draws with it the whole; and its purpose, whatever it portend, is gained—that is to say, the whole protoplasmic mass and contents have acquired their freedom, and the old parent-membrane is discarded and deserted. What immediately becomes of the "chlorophyll-plate" in this process I cannot say, but the whole contents become more granular, in which I suppose the plate likewise takes a part; or possibly it becomes consolidated in the centre, causing the dark central spot in the spore-like body formed by the emerged contents—it, at all events, affords no obstacle to a process which at first sight, and until it is properly considered, appears almost like a feat of *legerdemain.*

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[*] Loc. cit. ("Untersuchungen über d. mikr. Alg. u. Pilze"), p. 231.

[†] "Pflanzenphysiologische Untersuchungen."

[‡] Loc. cit. ("Iagttagelser," &c.), p. 29.

[§] Loc. cit. ("Untersuchungen über d. mikr. Alg. und Pilze"), pp. 228, 230.

[||] "Zur Naturgeschichte des *Protococcus pluvialis* (Kütz.)." In abstract, in Ray Society's Publication for 1853.

[**] Ibid., p. 733.

Not to multiply examples, let us refer, lastly, to the *modus operandi* of the process of conjugation in the genus Spirogyra. Two filaments in juxtaposition about to conjugate put forth from opposite cells, as is well known, short tubular processes, lined by a similar extension of the "primordial utricle" bounding their contents. This indeed so far seems to be only a process of *growth,* comparable to that which takes place in a joint of Cladophora when about to give forth a branch, or to that of the apex of the tubular filament of Vaucheria, &c. &c. But in the conjugating joints of Spirogyra, an actual contact and resorption of the intervening septa having taken place, so as to produce an uninterrupted connecting canal, there thereupon occurs a contraction of the cell-contents of the conjugating joints. Presently one of these protoplasmic masses passes over through the canal, to combine into a single spore with that in the opposite cell. Now, the collective mass which is about to pass over is actually of greater diameter than the transverse canal through which it has to make its way. This, of course, can only be effected by a process essentially similar to that which the cell-contents adopted or underwent in the curious exceptional case in the Mesotænium described by myself,—in other words, by calling into play its own inherent contractile power.

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* "Proceedings of the Natural History Society of Dublin," vol. iv., Part I., Plate I., Figs. 21, 22, 23, 24.

It is true that Professor de Bary,* in speaking of the wonderful phenomenon of the seeking out of the germ-cell on the part of spermatozoids, and of the not less wonderful phenomenon of conjugation, suggests that in the former instance the active ciliated spermatozoids, and in the latter the conjugating protoplasmic masses, are impelled by a kind of *attraction* exerted upon the other on the part of that which in either instance is the receiving cell. But granting that the motive force impelling in its normal direction the protoplasmic mass which actually passes over may be an *attraction* on the part of the other (this indeed must be a *mutual* attraction in those Conjugatæ which form their spores halfway), yet this does not affect the *modus operandi* of the actual change of place, that is, the means by which the locomotion is effected. In Œdogonium, Sphæroplæa, &c., this presumed attraction, then, draws over into its sphere bodies moving by cilia; but in Spirogyra it acts upon bodies, if I be right, moving their little distance in an amœboid manner. In either instance this presumed attraction may influence the ultimate direction of the movement of the bodies acted upon, but cannot excite that movement, nor can it affect the mode of progression. That it cannot excite it even in Conjugatæ is certain, as in the case of the Mesotænium observed by me, above cited, no such attractive force could exist: there was no conjugation; and the exit of the "primordial utricle" with contents was, so to speak, a purely spontaneous action,—a purely automatic relinquishing of its previous apparently too narrow limits, and, as I have above endeavoured to convey, by a kind of motion to all intents and purposes "amœboid" in its character.

In all these cases active mobility is evinced by the protrusion of what may be called indeed pseudopodal extensions; and the result, as in Amœba itself, is not only change of form, but actual locomotion.

It may be asked, where is the rolling, onward flow of the granular contents in the Mesotænium alluded to, and here, so characteristic and conspicuous in my amœboid bodies, and requisite to carry out the analogy? I believe the flowing movement of the contents in the latter is due to its granular condition; the granules, free and distinct from each other, are urged on by the contractile power of the bounding protoplasmic mass; they therefore naturally assume a flowing movement, to a certain extent resembling that of the blood-discs in the vessels of the higher animals. In the latter instances, on the other hand, the contents have not become at all so finely and freely disintegrated, and the whole contents are simply compressed and so moulded by the contractile power of the bounding protoplasmic mass as to become adapted to pass through a comparatively narrow outlet. In both instances the solid contents seem to be passive, and are urged along by the contractile power of the external protoplasmic mass. In the one instance, the contents, loosely granular, are powerfully and rapidly acted upon by momentary and ever fitful changes of the lobose expansions and the contractile efforts of the protoplasmic mass, and the granules *flow*. In the other, the contents, still maintaining a coherence and much of their original disposition, are slowly (but surely) acted upon by the gradual, and except at intervals imperceptible, but not less actual, contractile power of the protoplasmic mass, and they are thereby *carried with it*. Even in the latter instance there does exist a certain amount of the same kind of movement of the solid contents as in the former; but as the whole process is so greatly slower, and the contractile force comparatively so much less energetic, it is not so perceptible. In my mind the analogy is exact—the difference is in degree.

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* "Untersuchungen über die Familie der Conjugaten," pag. 59.

Now, let us for a moment imagine an *Amœba princeps* or *diffluens* imprisoned within such a rigid cyst as that of the parent-membrane of my *Mesotænium mirificum*, or within the cavity of a joint of a Spirogyra, and with only one narrow aperture, considerably smaller than itself by which it could possibly get free. Now, further, let us suppose our *Amœba* acted upon by the impulse to go out,—there can be no doubt but that it could perform the feat—and its *modus operandi*, so far as I see, would not essentially differ from that of the true vegetable cell, in actually effecting the same object in the course of its own natural developmental vital processes.

Starting, then, from such cases, and passing on through the more decidedly reptant amœboid bodies of Rhizidium, of the Moss, of Volvox, we arrive at the vigorously, and actively and freely crawling, energetically and comparatively rapidly locomotive, amœboid bodies of Stephanosphæra. We must regard, I think, the whole as manifestations of one and the same phenomenon—in the first, lasting for a shorter period, and more feebly and slowly evinced; in the latter, persisting for a longer period, and in the cases cited gradually more and more energetically and decidedly displayed, until (leaving the Myxogastres aside for the present), in the case of Stephanosphæra this extraordinary condition seems to culminate.

If this reasoning be correct, then, contractility, *amœboid* contractility—for I can find no more comprehensive and expressive single adjective term—must be accepted as an inherent quality or characteristic, occasionally more or less vividly evinced, of the vegetable cell-contents, and this in common with the animal; in other words, that the nature of the protoplasm in each is similar, as has indeed, as is well known, before been urged on grounds not so strong; thus reversing Siebold's doctrine that this very contractility formed the strongest distinction between animals and plants, as he assumed it to be present in the former, and absent in the latter of the two kingdoms of the organic world. Therefore an organism whose known structural affinities, and whose mode of growth and of ultimate fructification, point it out as truly a plant, but of which, however, certain cells may for a time assume a contractile, even a locomotive quasi-rhizopodous state, must not by any means on this latter account alone be assumed as even temporarily belonging to the animal kingdom, or as tending towards a mutation of its vegetable nature. And from this it of course follows that an organism whose structural affinities and reproduction are unknown, but which may possibly present an actively contractile, even locomotive, power, need not on this latter account be assumed as therefore necessarily an animal. In the former category fall the Volvocinaceæ and Rhizidium; in the latter category Euglena and its allies, the so-called Astasiæan Infusoria, suggest themselves; and these must of course wait until their reproduction and history are better known before we can feel satisfied as to their true position, yet it seems highly probable that these will presently, if they do not even now, take their place amongst admitted plants.

Several writers have indeed, from time to time, as is well known, put forward the (now, I think, generally accepted) view that the protoplasm of the vegetable and the sarcode of the animal cell are identical in nature; and, in seeking for analogies as regards contractility in the vegetable protoplasm as compared with the animal, and as demonstrative thereof, special attention has been directed to several of the now familiar phenomena displayed by certain vegetable cells. Such are the vibratory movement of cilia, the drawing in of these, the circulatory movements of the cell-contents, as in the hairs of the stamens of Tradescantia, &c., the contractile vacuole in Gonium, Volvox, &c., and so forth. But while these are, I think, unquestionably to a considerable, but more limited, extent, manifestations of the same phenomenon, it seems to me that none of these cases present so exact an analogy, strongly as they may indicate it, with the rhizopodous contractility, as do the amœboid bodies of Stephanosphæra, of Volvox, of the Moss-radicles, and of Rhizidium. The amœboid bodies of Stephanosphæra seem to display this rhizopodous contractility in greatly the most marked or exaggerated degree, as their vigorous and energetic powers of locomotion indicate; in them, and indeed in those of Volvox, of the Moss and of Rhizidium, the pseudopodal processes and their mode of protrusion and withdrawal, the flow of the granules, and the locomotion of the whole body, were in all respects analogous to the similar phenomena evinced by a true Amœba.

But I need hardly add, after what has been advanced, that I do not suppose for a moment that there was in these cases actually an absolute conversion of the vegetable cell into an animal. In the case of the Stephanosphæra and of Rhizidium, this condition is certainly but very temporary—a few hours at most, and the quasi-animal condition becomes relinquished for the strictly vegetable. In not one of the cases cited were there to be seen any foreign bodies of any kind within the substance of the amœboid structures. It may be said, indeed, so far as this bears upon the question, that it is only negative evidence; and in the case now brought forward there were very few, if any, foreign bodies at all existent in the material under examination. In his memoir, describing his recent and masterly researches on certain minute parasitic Fungi,*

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* "Ann. des Sciences Naturelles," IV. Serie, tome xx. (Botanique), p. 5; also "Flora" (1863), p. 163.

Professor de Bary makes the statement that not once in the course of his researches has he met with any case which would induce him to the view, that any single one of those parasites owes its origin to the changed contents of any cell, or of any intercellular fluid, of the infested plants. How much the more unlikely, then, is it that a true animal could have such a beginning, if the contents of the cells of the host-plant cannot give origin to a Fungus,—another denizen of the vegetable kingdom!

The advocates of a "third kingdom" intermediate between the animal and vegetable, as well as those who hold that, there being no distinction between animals and plants, an organism may be at one time an animal, at another a plant, or that the one may give birth to the other, will each, I suppose, think they can draw support from the facts adverted to in this paper. In my mind they are opposed to the arguments of both. Those who even in this day contend that Volvocinaceæ are animals will doubtless feel themselves confirmed in that view, on account of their occasional amœboid state, and on account of the parallelism to a certain extent with the Gregarinida. But what of Spirogyra, of Mesotænium (Conjugatæ), of Rhizidium (which probably should be referred to Fungi)—of Dr. Hicks' Moss? When, or at what point, do they cease to be vegetables, or are these varied organisms always animals? "No!" say the advocates for a half-and-between kingdom—"Nor plants either—they belong to the 'Protozoa' or 'Phytozoidea' or, 'Primalia,' or the 'Regnum primegenum.'" If so, must all the Confervoideæ, all the Algæ—must Dr. Hicks' Moss? Truly this "intermediate" kingdom would form a most heterogeneous and incongruous assemblage, here and there transferred—nay, even sometimes violently disrupted, from both sides. Those who may perhaps think this to be exaggeration, I would refer to Owen's "Palæontology" for "Protozoa"; to Perty, for "Phytozoidea;"* for "Primalia," to a paper published not later than May, 1863, "On a Third kingdom of Organized Beings," by Thomas B. Wilson, M. D., and John Cassin;† and for the "Regnum primigenum," to a paper by John Hogg, M. A., F. R. S., &c.—the last supported by a gaudy if not quite convincing diagram.‡

Either hypothesis, instead of removing or even smoothing any difficulties, seems to me to multiply them manifold, and to involve far greater dilemmas, and to plunge us more deeply into doubts and perplexities, than those with which we find ourselves obliged to contend, when, as I venture to conceive, the phenomena of nature and the simple facts are rightly and properly viewed.

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* Perty, "Zur Kenntniss kleinster Lebens-formen," pag. 22.

† "Proceedings of the Academy of Natural Sciences," Philadelphia, No. 3, 1863, p. 113. The latter writers, indeed, think to make short work of the difficulty by consigning the whole of the Algæ, Lichens, Fungi, Spongiæ, and Conjugatæ to the "Primalia."

‡ "On the Distinctions of a Plant and an Animal and on a Fourth Kingdom of Nature," by John Hogg, M. A., F. R. S., in "Edinburgh New Philosophical Journal," vol. xii., N. S., p. 216.

To say (with Schenk and many others) that there is no actual distinction between the animal and vegetable kingdom, whatever may be *intended* to be thereby conveyed, so far as I can see, is simply to say that a germ or partially developed organism may go on to find itself, when matured, at random, or as chance or circumstances may direct, either an animal or a plant, that is, that it is at one time an animal, at another a plant, or *vice versâ*. If people confined themselves to saying that certain phases in the development or history of certain organisms belonging to either kingdom are sometimes very difficult indeed, nay with our present limited acquaintance with them, perhaps impossible, to distinguish from similar phases of certain other organisms belonging to the other kingdom, then acquiescence becomes a matter of course. For, as I venture to think, it is only the development of an organism from its germ until it in turn reproduces its germs—its origin and destiny—the nature of its ultimate fructification—what it grew from, and what it ends in—its *tout ensemble*, in fact—and *no isolated or single phase or temporary condition in the course of its development*, even though protracted, that can decide the point as to its true nature. So far as I can at present see, the fallacy seems to me to lie in the assumption that a correct diagnosis as to the plant or animal nature of any organism ought to be made in a moment, at any given stage upon which we accidentally alight. It is true, indeed, that of very many of these doubtful or uncertain organisms, as they ordinarily present themselves to us, the life-history—the beginning and the end—is as yet very imperfectly known; upon such it would, of course, be premature to attempt to decide; nor can I see that such cases militate against the view here sought to be expressed.

> "Non semper ea sunt, quæ videntur, decipit
> Frons prima multos"—

is doubtless oftentimes as true of many of these lowly beings, in their way, as it is of men.

Unger, with the so-called cell-circulation in the vegetable, as well as the movements executed by ciliated zoospores, in his mind's eye, expressed himself thus—"The animal nature is in the plant, as it were, caged"—as if he would say, as it were, that if it could only escape its thraldom, it would be an animal. He would doubtless have considered himself doubly fortified in this view, had he known that a protoplasmic vegetable mass can (and does occasionally) assume an actually reptant amœboid state. But I do not see that such a view is in truth justified, so far at least as present knowledge goes. That a plant is a plant, and an animal is an animal throughout, we must I think certainly as yet hold, notwithstanding that certain phases of the one may under certain circumstances temporarily simulate certain phases of the other. I conceive that we must, in our present state of knowledge, continue to believe that these free amœba-like reptant masses of vegetable protoplasm *cannot*, any more than the isolated motile ciliated zoospores or spermatozoids, be of animal nature; for—although, for a while, with more points in common with certain true denizens of the animal kingdom than is ordinarily the case in the vegetable cell—(so far as we can *at present* see) the former, viewed retrospectively, have had an origin different from the animal which they may simulate, and, viewed prospectively, have before them a different destiny.

Whether I may eventually be right or wrong in the opinions in this paper ventured to be put forward (and in regard to which it were folly otherwise to aver than that I am not so wedded to them, as to be unprepared to relinquish them on sufficiently cogent evidence on the other side, though as yet I feel compelled to hold a present belief in their soundness), or whether such opinions may accord with those of others—the *fact* will still remain the same, that the membraneless primordial cells of the vegetable Stephanosphæra temporarily became amœboid, and crawled about as quasi-rhizopods; nor will that fact *per se* have lost its interest, I trust, on account of my tedious and awkward method of handling it. I add this, then, as another example of such a phenomenon to those already recorded in Volvox, Moss-radicles and Rhizidium, as one more humble contribution to the as yet indeed but comparatively slender stock of facts gleaned from the vegetable side of the organic world which bear on the question which I have ventured to discuss, and from which, when by degrees hereafter enlarged and strengthened, it is to be hoped that ultimately the Truth, as regards that question, may be evolved.

X.—ON THE OCCURRENCE OF SPIRAL VESSELS IN THE THALLUS OF EVERNIA PRUNASTRI (ACH.; LINN. sp.). By Admiral T. JONES, F. L. S., F. G. S.

[Read before the Natural History Society of Dublin, June 8, 1864.]

WHILST examining the Thallus of *Evernia prunastri*, gathered at Curraghmore, my object being to ascertain whether certain dark spots on it were parasitic, fungoid, or of insect origin, I was surprised to find bundles of spiral vessels. The portion under examination on the table of the microscope was necessarily very minute. I satisfied myself that the dark spots were occasioned by insects; but after repeated attempts, I did not succeed in again finding spirals. It is, however, desired to record this occurrence of spirals, and Mr. Archer has very kindly made a sketch of them, which accompanies this paper (Plate I., Figs. 7, 8, 9, 10). I have always taken the greatest pains to perfectly clean the glasses I use in microscopic examinations, and I do not believe any error has been occasioned by neglect of this necessary precaution; but as I failed in my attempt to find these spiral vessels a second time, I think it prudent merely to record their occurrence.

Admiral Jones exhibited the original specimen of *Evernia prunastri*, bearing the black dots, within the substance of one of which he had found the remarkable spiral vessels forming the subject of the present communication.

Mr. Archer, who had to thank Admiral Jones for having kindly afforded him an early opportunity to examine the singular preparation obtained from the lichen in question, believed that the drawings thereof which he had endeavoured to make conveyed at least a correct idea of the vascular bundles themselves thus found in a plant so unexpected. He did not consider these "vessels" were any of them "scalariform," or "annular," but were strictly "spiral." After examining the specimen very carefully, he was in very few instances able to see the ends of these spiral vessels, owing to their being, without injuring the preparation, so inextricably immersed in the brown cellular mass, mixed with fragments of coarse pellucid fibres, which together seemed to form the substance or tissue producing the dark dots apparent on the surface of the lichen, and which had first attracted Admiral Jones's attention. Mr. Archer stated, however, that where he had been able to see the extremities of the vessels, he had found that they gradually tapered; and he drew attention to one instance depicted in the sketch, in which one had been broken off by the pressure, and the fibre uncoiled—thus proving its strictly spiral character (see Plate I., Fig. 9). These vessels, indeed, by mutual contact, sometimes acquired somewhat flattened surfaces for a considerable length, and the fibres, following the angles thus produced, assumed sometimes an apparently transverse ("annular"), or, when the angle of the vessel rendered itself especially evident, a sub-scalariform appearance; but he thought, nevertheless, that the fibres were throughout actually spiral (see Figs. 8 and 9). Mr. Archer adverted to what appeared to him to be a singularity of the vessels forming these vascular bundles. This was, that not unfrequently certain (sometimes several) vessels, running up and down, parallel with the other vessels of the bundle, upon meeting, did not overlap, but suddenly diverged at right angles from the rest, and were prolonged concurrently in a direction vertical to them, and parallel and juxtaposed to one another, the entire bundle thus forming somewhat the figure of a T (see Figs. 9 and 10). This seemed to be something different from the bundles merely giving off what might be called branches, or simply divaricating. He ventured on this observation for information's sake, and would leave to those acquainted with the histology of the higher plants the decision as to whether this was a circumstance of special singularity or weight. He thought, then, that this seemingly unusual arrangement, coupled with the apparent completeness and intimacy with which these vascular bundles were immersed in the brown indefinite cellular mass, whatever may have been its origin, seemed to point to the conclusion that they actually belonged thereto, or at least were found in it, and were not accidental foreign intruders during the manipulation, which latter assumption, indeed, Admiral Jones's well-known scrupulous care would *à priori* forbid. This assumed, then, notwithstanding that Admiral Jones's researches had not disclosed any more of these spiral vessels, the observation thus recorded seemed of very great interest, and, as far at least as it went, noteworthy in a very high degree.

Dr. Grimshaw coincided with Mr. Archer that the circumstance of the vessels forming the bundles standing out at right angles from the rest, in the manner which had been drawn attention to, was singular, and he was not aware of a similar instance.

XI.—GEOLOGICAL NOTES ON SOME OF THE ISLANDS OF THE WEST OF SCOTLAND. By the Rev. SAMUEL HAUGHTON, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Geological Society of Ireland, December 14, 1864.]

THE following brief notes, mineralogical and geological, made during a yachting cruise in the West of Scotland, on board Mr. Graves' yacht, "Ierne," in the summer of 1864, may possibly be interesting to the Royal Geological Society of Ireland, in consequence of the intimate relation between that part of Scotland and the North of Ireland:—

1. *Crystalline White Limestone of Iona.*—On the 17th of July we visited the metamorphic white Limestone of Iona, described by Jamieson and others. It bears N. 15° E. by compass, and dips 80° E., and is from 40 ft. to 50 ft. in thickness. It is pure white, and has a remarkable flaky appearance, which is fully explained by its mineralogical composition.

On being analyzed, it was found to consist of—

1. Dolomite,	70·7
2. Silicate,	29·3
	100·0

The Dolomite was found to have the composition—

1. Carbonate of Lime,	82·5
2. Carbonate of Magnesia,	17·5
	100·0

The Silicate gave, on analysis—

		Atoms.	
Silica,	59·00	1·311	3
Alumina,	0·64		
Lime,	12·44	0·444	4
Magnesia,	27·01	1·350	
	99·09		

This corresponds to the formula

$$4\,(MgO,\ CaO),\ 3\ SiO_3,$$

and the mineral must be regarded as a variety of Tremolite.

At the time of our visit it was nearly high water, and we were therefore unable to examine the portion of the Limestone which is exposed at low water, and which is said to pass into Verde Antique, of which, indeed, we found several rolled pebbles on the strand.

2. *Labradoritic Syenite of Loch Scavig, in Skye.*—We visited the remarkable mountains that surround this wild Loch on the 3rd August, and brought away with us very good specimens of the Syenite of which they are composed.

The mass of the rock is a medium-grained Syenite, composed of Augite and Labradorite, and was particularly interesting to me, because I had failed to find this rock in Donegal, although there are specimens collected by the late Mr. Townsend, C. E., probably from Donegal, in the Geological Museum of Trinity College.

Beds of metamorphic rocks, in which Labradorite forms an essential constituent, are well known to form an important part of the Laurentian system in Canada, and I was therefore glad to have an opportunity of examining a similar rock *in situ* in Scotland.

The Syenite is bedded, and evidently metamorphic, and is penetrated frequently by dykes of similar Syenite, sometimes finer, sometimes coarser in the grain. In the coarsely crystallized masses, the Labradorite and Augite acquire large dimensions, and are associated with a considerable quantity of Ilmenite, such as is found in the Oligoclasic Syenite of Horn Head, in Donegal.

The following analyses show the composition of this Syenite, and of its two constituent minerals :—

Loch Scavig Syenite.

Silica,	48·12
Alumina,	23·40
Protoxide of Iron,	3·28
Protoxide of Manganese,	1·68
Lime,	15·43
Magnesia,	5·31
Soda,	1·86
Potash,	0·03
Water,	0·48
	99·59

Felspar of Scavig Syenite.

	Percentage.	Oxygen.	Atoms.	
Silica,	53·60	27·829	9·276	2
Alumina,	29·88	13·964	4·655	1
Protoxide of Iron,	0·20	0·044	4·599	1
Lime,	11·02	3·132		
Magnesia,	0·07	0·027		
Soda,	4·92	1·261		
Potash,	0·80	0·135		
Water,	0·48			
	100·97	46·392		

This analysis gives us very accurately the formula of Labradorite, of which it is an excellent example.

An examination of the cleavage planes of the Hornblendic constituent of the Syenite proves that this mineral is Augite, and not Hornblende; for its cleavage planes are nearly at right angles to each other, and this crystallographical proof is further confirmed by the chemical analysis, which gave the following results:—

Hornblende of Scavig Syenite.

	Percentage.	Oxygen.	Atoms.	
Silica,	50·80	26·376	9·259	2
Alumina,	3·00	1·402		
Protoxide of Iron,	9·61	2·132	14·040	3
Lime,	19·35	5·501		
Magnesia,	15·06	6·018		
Soda,	0·44	0·112		
Potash,	0·22	0·036		
Protoxide of Manganese,	1·08	0·241		
Water,	0·60			
	100·16	41·818		

This result corresponds with the well-known formula for Pyroxene,

$$3RO,\ 2SiO_3.$$

3. *Granite of Ross of Mull.*—On the 17th July we visited the celebrated Granite quarry of the Ross of Mull, from which it was proposed to obtain the monolith in honour of the late Prince Consort. The Granite is coarse, with Quartz abundant, and only one Felspar, viz., a pink Orthoclase, with a little black Mica.

Its analysis shows that it differs much from the Granite of Strontian,* two analyses of which were published by me in the "Quarterly Journal of the Geological Society of London," in Part IV. of my "Experimental Researches on the Granites of Ireland."

Granite of Ross of Mull.

	Percentage.
Silica,	74·48
Alumina,	16·20
Peroxide of Iron,	0·20
Lime,	0·13
Magnesia,	0·27
Soda,	3·78
Potash,	4·56
Water,	0·60
	100·22

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* One of these Granites is published, on the authority of Sir R. Murchison, as from Tobermory, but I believe it was originally a specimen from Strontian, and was brought to Tobermory as a building stone.

4. *Gryphæa Beds of Loch Aline.*—On the 15th of July we visited these beds, and found them to consist of decomposing dark beds of shaly Limestone, at the sea level, abounding in *Gryphæa incurva*, *Pecten quinquecostatus*, and a species of Lima; above the shaly Limestone lie thick beds of White Sandstone, without fossils; and this Sandstone is again covered by thick masses of tabular Basalt.

5. *Tertiary Leaf Beds of Ardtun Head.*—On the 18th of July we rowed across from Iona Bay to Ardtun Head, and were shown the Tertiary leaf beds by Mr. Campbell, who kindly provided us with blasting powder and jumpers, by means of which we succeeded in obtaining some excellent specimens of *Platanus Hebridicus*. This was the only fossil leaf we found, and it was obtained in the bed of Shale that underlies the bed of Conglomerate formed of chalk flints and chalk pebbles.

6. *Lias Beds at Tobermory.*—On the 20th July examined the lias Shale of this locality, in the roadway leading to the Baptist Chapel. I found it to contain Liassic Belemnites, Ammonites, and Terebratulæ. The Shale beds are covered by massive Trap. The Red Sandstone, on which some of the houses in Tobermory are built, appears to lie under this Shale, but I was unable to determine whether it is Old or New Red Sandstone.

7. *Lias Beds of Pabba.*—We visited the island of Pabba on the 1st August, and brought away, by diligent quarrying, a good collection of fossils. These were kindly examined and named for me by Mr. Baily, Palæontologist of the Geological Survey of Ireland, who possesses special knowledge of these fossils, from the fact of his having assisted Professor Forbes in the determination of the Oolitic fossils found by him at Loch Staffin, in Skye. The following were the principal fossils found by us:—

1. *Serpula vertebralis* (Oxford clay and Cornbrash).
2. *Rhynchonella lacunosa* (*vide* Davidson, Pal. Soc., Pl. xvi. Fig. 15, from Lias, Skye).
3. *Lima læviuscula* (closely allied to *L. gigantea*, Lias).
4. *Pecten fibrosa?* (like *P. æquivalvis* of Lias).
5. *Gryphæa dilatata.*
6. *Pinna mitis?* (Phil., Pl. v., Fig. 7. Oxford clay species, found at Loch Staffin; *vide* Forbes on the Oolites of Skye, "Proc. Geol. Soc.," vol. vii., p. 110.)

8. *Oolite Beds of Mull.*—On the 5th August, we landed at a new locality for fossils, on the east side of Mull, pointed out to us by Mr. Campbell, of Aros, Tobermory. We found Shale beds at the sea level, converted into flinty Hornstone, of a greenish colour, by enormous masses of amorphous Trap that covered them; and it was with much difficulty we brought away the few fossils we quarried out, as there was a heavy sea running on the shelving rocks, and our gig was in some danger of being stove in.

Mr. Baily has named the following:—

1. *Pecten, sp.* (with large ribs).
2. *Belemnites Oweni?* (Oxford clay species, from Skye).

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CONTENTS OF No. XVII.—JANUARY, 1865.

With Four Plates and numerous Woodcuts.

PAGE

1. On the Sea Fisheries of Ireland, and with Reference to Trawling. By William Andrews, M. R. I. A., President of the Natural History Society of Dublin. (Plates II., III., IV.), ... 1
2. Further Notes on Salmonidæ. By William Andrews, M. R. I. A., . [illegible]
3. On the Death of the Lion and Ostrich in the Royal Zoological Gardens of Dublin. By the Rev. Samuel Haughton, M. D., F. R. S., Secretary of the Royal Zoological Society of Ireland, ... [illegible]
4. On Irish Vespidæ. By Richard L. Edgeworth, ... [illegible]
5. Catalogue of the Mammalian Fossils which have been hitherto discovered in Ireland. By Robert H. Scott, M. A., ... [illegible]
6. On the Occurrence of *Hymenophyllum Tunbridgense* (Smith) in the Co. Longford, with a List of Stations of *Cystopteris fragilis* (Bernh.) in the Midland Counties. By F. J. Foot, M. A., F. R. G. S. I., [illegible]
7. On Flights of Swans seen in the Counties of Roscommon and Galway, during the Winter of 1863-64. By F. J. Foot, M. A., F. R. G. S. I., [illegible]
8. Notes on some Dissections of the Fresh-water Pearl Mussel (*Unio margaritifera*). By John Barker, M. D., M. R. I. A., ... [illegible]
9. Record of the Occurrence, new to Ireland, with Note of a peculiar Condition of the Volvocinaceous Alga *Stephanosphæra pluvialis* (Cohn), and Observations thereon. By William Archer. (Plate I.), . . [illegible]
10. On the Occurrence of Spiral Vessels in the Thallus of *Evernia prunastri* (Ach.; Linn. sp.). By Admiral T. Jones, F. L. S., F. G. S., . [illegible]
11. Geological Notes on some of the Islands of the West of Scotland. By the Rev. Samuel Haughton, M. D., Fellow of Trin. Coll., Dublin.

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N° XVIII.
APRIL, 1865.

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XII.—ON AN ABNORMAL MORPHOLOGICAL DEVELOPEMENT OF THE COMMON SNOWBERRY. By ALEXANDER MACALISTER, M.D.

[Read before the Natural History Society of Dublin, March 4, 1864.]

THE specimen which I have the honour to bring before the notice of the Society this evening is one of a rather rare abnormal morphological developement of the Snowberry, *Symphoricarpus racemosus*. It was gathered by Mr. De Landre, of Waterloo, county of Waterford, from a shrub in his garden, and by him was transmitted to me. When I received it, I was struck with its appearance; it exhibited a raceme of berries, in different states of developement, the two lower of which were crowned by a circlet of leaves. This plant belongs to the Natural Order Caprifoliaceæ, and has a superior toothed gamosepalous calyx, the remains of which are persistent on the summit of the berry. In this case, their place is taken by well-developed lanceolate foliar organs. When first gathered and sent up, each berry was crowned with five leaves; but in the transference from a narrow-necked bottle to the jar in which at present they are, three of the leaves were detached from one, and two from the other. I have, however, preserved these and fastened them to the upper part of the sheet of talc on which they are mounted. These leaves, as may be seen, are closely connected at the base, and their midribs seem to be continuous with the woody bundles on the outer coating of the berry. These leaves appear to me to be a modified calycine whorl, from their position, and form a striking illustration of the law of morphology established by Goethe—that all the parts of the flower are modified leaves. All such monstrosities are interesting, as showing the operations of the ordinary causes which produce the growth of these parts under unusual circumstances.

I might mention, in passing, the curious fact in relation to the ovary of this plant which was noticed by Robert Brown—that in the immature condition it consists of four cells, two of which are many-seeded, and two single-seeded; but in the mature berry there are only two loculi, which correspond to the one-seeded cells, as the many-seeded cells become undeveloped and abortive.

Göppert, in the "Proceedings of the Silesian Society," notices a curious instance of metamorphosis somewhat similar, occurring in a plant of *Tragopogon orientale*, in which the pappus was changed into small lancet-like pointed leaves, and even some of the filaments were similarly metamorphosed.

Dr. Moore said the specimen shown was a remarkable example of abnormal formation, where the fruit was "inferior." It showed the truth of the doctrine propounded by Goethe, that all the parts of a flower are merely modified leaves. A number of small strawberries may sometimes be found growing round the base of a common strawberry. But the strawberry being a "superior" fruit, and having the calyx underneath, that made the difference in the position of the abnormal formation. The nature of the development was, however, the same in both cases. Few plants with inferior fruits presented anything like what was exhibited; but with superior fruits it was more to be expected and more common.

Mr. R. P. Williams said he had seen examples of the Snowberry in which the stem seemed to have passed right through the top of the fruit, and then a number of small fruit were produced upon the new extremity. He had had in his own possession specimens of the Snowberry growing in the way he described, but the plant which had produced these curious examples had been unfortunately dug up.

XIII.—DESCRIPTION OF A NEW SPECIES OF DOCIDIUM (BRÉB.), FROM HONG-KONG. By WILLIAM ARCHER.

[Read before the Natural History Society of Dublin, December 4, 1863.]

Family, DESMIDIACEÆ.
Genus, Docidium (*Bréb.*)
Docidium Kayei (sp. nov.).

Specific Characters.—Frond stout, about five times longer than broad; segments with four whorls of prominent short stout hyaline quadripartite spines, and a terminal whorl of hyaline simple spines; ends truncate.

Locality.—Kowloon, on the mainland, opposite Hong-Kong.

General Description.—Frond about five times longer than broad, stout; suture forming a somewhat prominent rim; segments about two and a half times longer than broad, slightly and gradually tapering, with four prominent transverse whorls of short stout hyaline quadripartite spines, their points divergent and subacute, and with a fifth whorl, just under the ends, of short stout subacute simple spines; ends broad, truncate. The margin of the body of the segments presents an undulate outline (including the terminal) forming five prominences and four intervening depressions. It is of course only the marginal prominences which impart this undulate outline—they really form whorls (Mr. Kaye informs me ten in each whorl), and on their summits are seated the hyaline quadripartite spines, forming gradual continuations of the prominences, and which are here so characteristic. The basal undulation, as is usual in this genus, is somewhat larger than the others, which very slightly and gradually diminish upwards. The terminal clear space in the endochrome large, circular, well-defined; active granules very numerous.

Measurements.—"Length of frond $\frac{1}{87}$, breadth $\frac{1}{400}$ of an inch" (Kaye, in litt.).

Plate I., Fig. 2.

Affinities and Differences.—The whorls of hyaline quadripartite spines abundantly separate this beautiful species from every other belonging to this genus, or to Triploceras (*Bailey*). In outlines of frond, indeed, it seems much to resemble *Docidium nodosum* (Bailey), but that species is quite destitute of spines. There is no other species, taking even the general form of the frond merely into account, and irrespective of the spines, with which, so far as I can see, there is the least necessity to contrast this form. The spines seem to me to be quite similar in structure to those of *Xanthidium armatum* (Bréb.). The extremities are not at all lobed, but are abruptly truncate; and hence this species cannot be referred to the genus Triploceras (*Bailey*).

Mr. Kaye having kindly placed at my disposal, accompanied by his valuable remarks, the very graphic drawing (executed by his friend Dr. Lauder), from which the figure is taken, it affords me very great pleasure indeed to avail myself of the opportunity to call this beautiful and very distinct species after his name, as an humble mark of esteem, and in reminiscence of some pleasant hours.

XIV.—ACCOUNT OF OGHAM INSCRIPTIONS IN THE CAVE AT RATHCROGHAN, CO. ROSCOMMON. By SAMUEL FERGUSON, Q. C.

[Read before the Royal Irish Academy, November 14, 1864.]

THE principal remains at Rathcroghan, formerly the residence of the provincial Kings of Connaught, are indicated on sheets 21 and 22 of the Ordnance Survey Map of the county of Roscommon, and have been described in some detail by O'Donovan in a note to his translation of the "Annals of the Four Masters," at A. D. 1223, and more fully in letters preserved among the MS. materials for the intended "Ordnance Survey Memoir," and now deposited in the Library of the Academy (14 F. 8, p. 191, *et seq.*).

Among these remains may be noticed on the map, 310 yards northwest of the ancient sepulchral enclosure called Relig-na-Ree, or the Graveyard of the Kings—a spot marked with the name *Owneygat*, that is, the Cat's Cave, of which the following account is given in the MS. letters above referred to:—

"There are two remarkable caves in the townland of Glenballythomas, of which the more remarkable is called Uṁaıḋ na ᵹcaτ, because wild cats used to hunt rabbits in it. I walked into this a considerable distance, and saw its fine roof and hanging spars, like icicles, but will leave the description of it to geologists. The country people say that a woman followed a calf into this cave, and that she could not stop him till he came out at Keish Corran. I went as far into it as any one could, that is, until it terminated in a cleft, not wide enough to admit my head. This, according to tradition, was the Bank of Ireland in the time of Queen Mab; but if it was, the drops from the Gothic roof of the edifice must have injured the bank notes very much. A truer tradition connected with it is, that one Croghan, a rebel, lived in it after the rebellion, and by so doing saved his neck from the halter."

On examining this cave, on the 30th of September, 1864, the writer observed inscriptions in the Ogham character, on two of the roofing stones of its upper chambers or galleries. Part of the inscription on each stone was built into the structure, so that the stones before being placed must have been already sculptured. Whatever the age of the cave, the inscriptions must, therefore, have at least an equal antiquity.

The cave has always, within literary memory, been regarded as of the epoch of Meave, the celebrated Queen of Connaught, who lived about the beginning of the Christian era. The *Tain Bo Cuailgne,* or Cattle-Spoil of Quelgny, commemorates an expedition led by this heroine of antiquity into Ulster during the reign of Conor Mac Nessa, whose death is made, in Irish traditionary history, to synchronize with that of our Lord. She was daughter of Eochaid Fidleach, by whom the principal fort, or royal dwelling at Rathcroghan, is said to have been erected. Her name, which popular tradition has impressed on a great number of places in Ireland, is in its simplest form spelled MEDBH, equivalent to MEDF. Some one intimately connected with her family was called FRAECH. Such is the name given to her son-in-law in the ancient historical tract called the "*Tain-bo-Flidisi,*" one of the introductory stories which constitute the preface to the *Tain-bo-Cuailgne.* She had many sons, by different fathers, and has left a vivid recollection of her name throughout the west of Ireland. That she lived at Rathcroghan at a period before the introduction of Christianity into Ireland is a fact which no one, in the present state of historical knowledge, will be disposed to deny.

The earliest notices of the cave appear to treat it as a treasury house of Meave and her husband Ailill. It is so represented in the *Tain-bo-Aingin,* another of the introductory or pre-tales of the *Tain-bo* of Quelgny. Such also was the tradition of the country in 1838, when O'Donovan made his communications to the Ordnance Office. The same idea still exists among the peasantry of the country, by whom the interior of the cave has been repeatedly explored within the last twenty years, in the hope of finding treasure. Their operations have resulted in the falling in of the earth, which now chokes up the western end of the cave, and renders it impossible to say how far it extends.

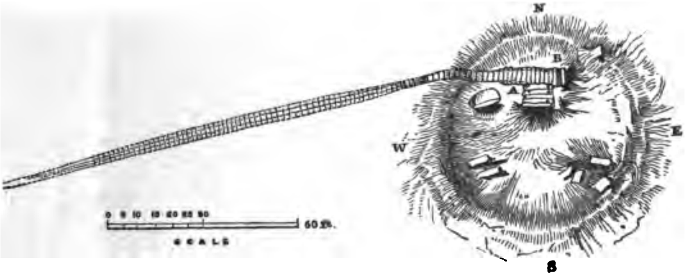
The writer is indebted to W. M. Hennessy, Esq., for the following further notes in reference to this cave:—

"In the list of celebrated places preserved in a stave of the 'Book of Leinster,' which is really a portion of the 'Book of Lecan,' the cave of Cruachan is described as one of the three caves of Ireland,—the other two being the cave of Howth, and the Derg Farna, now known as the cave of Dunmore, near Kilkenny. This tract, from its language, appears to be of very high antiquity.

"In the historical tale called the *Tain-bo-Ainghin*, or the Cattle Spoil of Ainghin, preserved in the 'Yellow Book of Lecan,' the cave of Cruachan is referred to as the residence of a fairy community; and some interesting particulars regarding the proceedings of its denizens are related by a person who, for some slight to a fountain fairy, was condemned to a year's residence therein."

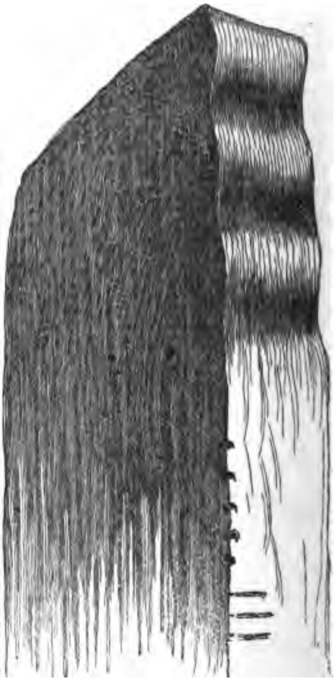
It consists of a natural fissure in the limestone rock, which appears to have been artificially widened, so as to give an average breadth of five feet throughout a distance of about forty yards. This cavern, the floor of which is from fifteen to twenty-five feet under the surface, is connected with the upper chambers, in which the inscriptions exist, by a passage excavated in the rock, and roofed over, as are the external chambers, by long stones, artificially placed, and bonded into the dry stone walls forming the sides of the passages or chambers near the surface. Whether these upper passages be entrances to the cave, or chambers to which the cave itself served as an entrance, may be a matter of doubt. They are two in number—one forming a prolongation, at a higher level, of the natural cavern, the other opening upon it at right angles. Around these openings exist the remains of a tumulus of about twenty yards in diameter. The subjoined woodcut exhibits the general appearance and disposition of the parts, the dotted lines representing the underground constructions.

Fig. 1.



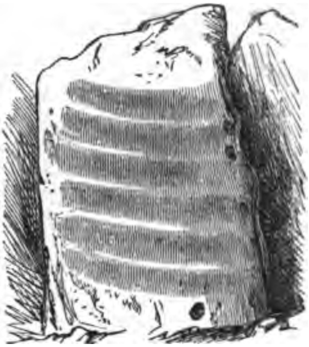
The traces of several interments remain about the margin of the tumulus; and one nearly perfect sepulchral cist exists within a few feet to the west of the lateral chamber, which now forms the principal approach. This chamber may be portion of a covered avenue, or it may be portion of a separate apartment. It is entered from a depression on the surface opening to the south, which bears the appearance rather of a breach made into the end of a chamber than of a passage. About seven feet in length of the covered part remains. The width is three feet eight inches; the height, from the clay which has fallen in, and forms the floor, not more than three feet three inches. At the junction of this crypt with the eastern opening, a species of transept is formed, about eight feet by four, and four feet high, extending eastward into the remains of what has now the appearance of a passage, and opening on the western side into the narrow gallery formed in the rock, which descends by a series of inclines and rude steps into the principal apartment below. In this lower interior the natural walls of rock rise to a height of about eighteen feet, converging at top, and having much the appearance of the inclined passages in the Mexican pyramids. The spaces between the rock ledges at top are, as are the upper passages and chambers, covered in with transverse blocks of stone. These stones, where they form the lintels at the junction of the upper chambers, have been selected with care; and it is on the lintel stone of the southern crypt, marked A on the plan, where it abuts on what has been described as the transept, that the principal inscription exists.

Fig. 2.



This stone, which is of the limestone of the neighbourhood, measures four feet eight inches in length, of which one foot is engaged in the adjoining masonry. It has an average breadth of one foot four inches, being somewhat broader towards the western end, and varies in thickness from four to nine inches. Its under surface is corrugated in the direction of its length with numerous natural striæ; and it does not appear to have undergone any preparation with the tool, except at one point, on the inner edge, at the eastern end, where it presents the appearance of having been rubbed down, so as to form two ribbed projections, separated by shallow grooved indentations, resembling the analogous work on one of the stones of New Grange, which has been figured in Wilde's "Beauties of the Boyne and Blackwater" (p. 194).

Fig. 3.

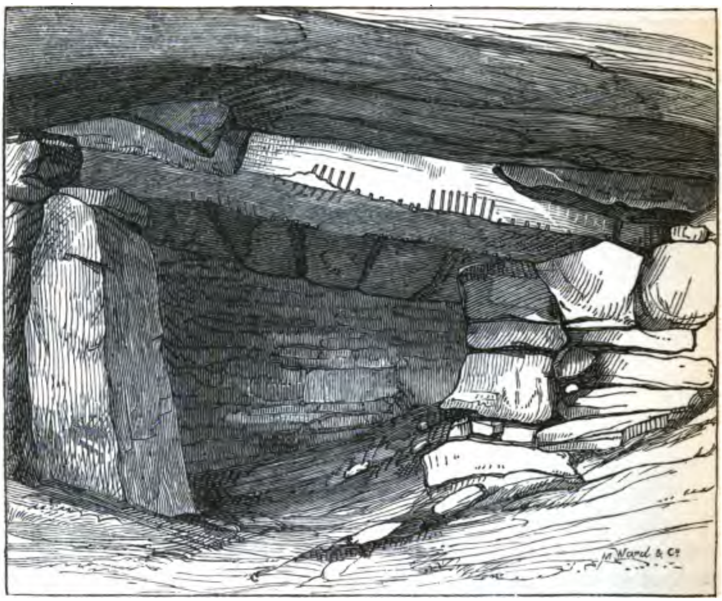


Ribbed Stone in gallery at New Grange.

Something of the same kind is also observable on one of the Ogham inscribed stones in the Academy's Lapidarian Museum, No. 5. These indentations, whatever object they may have had, appear to indicate that this is the upper end of the stone, and raise a probable conjecture that it originally stood upright. They are not carried across the face of the stone, nor do they appear on the opposite edge. Seven, or possibly eight, Ogham characters exist on the external edge and face, and ten on the internal edge and face of this lintel. The external appearance of the stone, with its inscription, is shown on the annexed woodcut, Fig. 4. There is, at the right hand, detached from the inscription, an indentation on the edge-line of the stone, too faint to be relied on with any certainty; but which may possibly be a single notch, standing for the vowel a. A circular disc or dot appears above this indentation on the edge near the end. This also is uncertain, and is not shown on the drawing. Two vertical strokes, connected with some curved indentations, apparently artificial, also exist on one of the stones forming the jamb or *quoin* of the passage on the right. They are too uncertain to be practically relied on, and are only hinted at in the woodcut. The character of these indentations has a general resemblance to that of some of the rubbed lines appearing on the stones of the chambers at New Grange and Dowth.

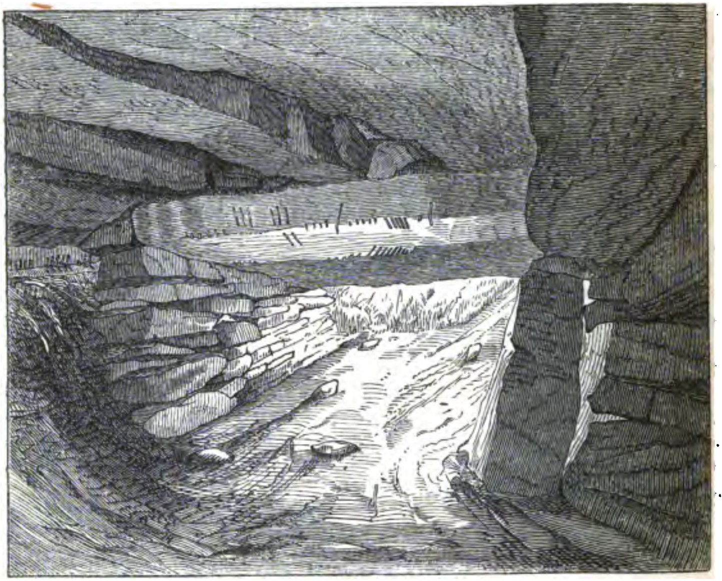
When first observed, the lintel was partly concealed by a block of stone, constituting portion of the eastern side wall, and covering part of the final character at that end. The removal of this block enabled the writer to examine the whole under surface and edge, and to state that no further inscribed marks exist upon it.

Fig. 4.



The internal appearance of this lintel is shown below.

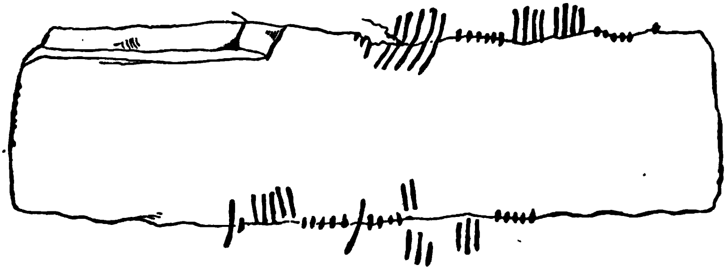
Fig. 5.



The extended inscription is also given, so as to exclude the errors incident to perspective.

Fig. 6.

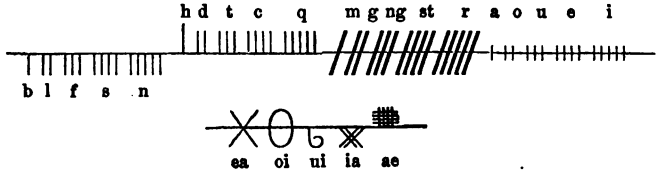
Outer Edge.



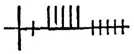
Inner Edge.

Before proceeding further in the consideration of these characters, it may be interesting to those members of the Academy who have not given special attention to the subject, that something should be said of the nature of the Ogham writing, and of the existing means for its deciphering. It was a species of cipher, in which straight strokes engraved on monumental stones, by their number and relation to a particular line, called the stem-line (generally formed by the edge of the stone), represented the letters of an alphabet. Facility of engraving with rude implements, rather than a desire for secrecy—for who would desire to commemorate in signs not generally understood?—may have been the original motive for the use of this species of writing. The value of the characters depending on the number of strokes, and these numbers increasing in a progressive ratio in sets of five—that is, five groups below, five above, five obliquely across, and five directly across, or on the stem-line—it is obvious, that if purposes of secrecy or curiosity were desired, the cipher might be made more or less abstruse by varying the number of the strokes; as by beginning with two or more at the commencement of each series; and a great number of examples of such cryptic Oghams may be seen in the tract on this subject in the "Book of Ballymote." They are all, however, resolvable into the original key-cipher, in which each set of five commences with a single stroke; and which, with the other more complex examples, and certain arbitrary marks for vowel combinations, is also found in the same depository. With this key, available for the last five hundred years, we may be surprised to find the Ogham character still involved in so much mystery. This may be, in some measure, accounted for by the discredit brought on the subject by a paper in our own "Transactions," at an early period in the history of the Academy, in which a supposed passage from one of the Ossianic poems was adduced in elucidation of an Ogham inscription existing on Callan Mountain, in the county of Clare

("Transactions R. I. A.," vol. i., Antiq., p. 3). The passage appears to have found its way into the text from a modern source; and the charge of falsification extended itself, with questionable justice, as it seems to the writer, to the inscription itself. Added to this disaster at the outset of the inquiry, were the really great obstacles arising from the singularity of the names, and from the absence of any clue to the sequences of which the writing ran, whether from top to bottom, from left to right, or *vice versâ*. It was not till our President undertook the investigation in the character on the scientific principles applicable to cipher-writing in general, that the subject again attracted a philosophic interest. His results, arising on independent analysis and comparison, are understood—for as yet the complete paper has not been published—to have come out in substantial accordance with the old key; and in a short paper in our "Proceedings" (vol. iv., p. 358), he adopted and published the "Ballymote Key," which, with some slight difference, had also been given by Dr. O'Donovan in his "Irish Grammar," and by other earlier writers.



In the course of these investigations our President early identified the group,



reading *Maqui*, as the genitive form of *Mac*, a son—a conclusion which was destined to receive corroboration of the most convincing kind from a source not then known to be in existence. The writer here refers to those monumental stones of Wales, which bear inscriptions in Roman characters with accompanying Oghams. These Oghams, rendered according to the key so furnished, have been found to yield results confirmatory not only of the alphabetic force of the characters, but of their proper sequences and collocations, as indicated by the independent method of investigation employed by our President. The Welsh Oghams so tested have, in fact, been found to resolve themselves into an echo of the correlative Roman writing. One of these inscribed Welsh pillars, which may be justly called the Rosetta Stone of the investigation, is in effect both bilingual and bi-literal. It commemorates in Latin words and Roman characters a person called Sagran, son of Cunotam, in the form (Lapis) *Sagrani Fili Cunotami*. An Ogham on the edge of the same stone reads *Sagramni Maqi Cunotami*. Here we have *Maqui* as the equivalent of the Latin *Filii;* and must acknowledge the conclusion to be very cogent that in Irish monuments of a cognate kind, wherever we find the combination of Ogham characters which sounds "*Maqi*," we may expect, before it, the name of the person commemorated, and, after it, the patronymic of that person. Such, in fact, is the formula of commemoration found on great numbers of the Irish Ogham monuments. The writer instances in our own lapidarian Museum, No. 7, *Qunilogni Maqi D***; Nocati Maqi, Maqi Rett***, No. 11; and in Mr. Du Noyer's collection *Logoqi Maqi Erenan* (Du Noyer MSS. Lib. R. I. A., vol. i., No. 43). *Erc Maqi Maqerti*, ibid., No. 27; *Lafi cas Maqi Muce*, ibid., No. 27; and numerous similar examples in the publications of the other Irish Archæological Societies.

The presence of this well-known combination of strokes and notches, reading MAQI, at the western end of the legend on the inner edge of the Rathcroghan stone, taken in connexion with the other indications of that being the lower end of the stone, and with the generally observed rule that these inscriptions read from bottom to top, and from left to right, leaves no reasonable doubt that the remainder of that line contains the patronymic, and the line on the opposite side the name, of the person commemorated. Reverting to the opposite side, and reading it from bottom to top, and from left to right, and according to the ordinary key, it presents a combination of characters, of which – R – CCI are free from doubt, and of which it is not impossible that the three strokes occupying the place of the first blank represent F, and the six notches occupying the place of the second blank stand for AI; in which case this part of the legend would read FRAICCI. The difficulty in respect to the first set of characters arises from a fracture of the stone, which leaves it in doubt whether the third stroke crossed the line of the edge. In that case, the reading would be OMR – CCI. The six notches represented by the second blank may either be a double U, or may read EO, or OE, or in any of the combinations of AUO. The name, whatever it be, seems to be in the genitive form, and to imply some such expression as "the stone of" before it.

Leaving this portion of the inscription, and coming to the patronymic, it is certainly startling to find it read, as it does in this collocation and sequence, without doubt or difficulty,

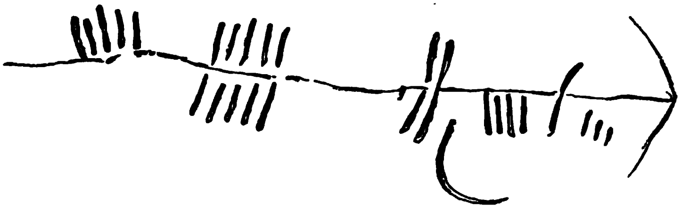
MEDFFI,

—that is, collating the several parts of the legend,

"(The stone of) [FRAIC?] son of Medf."

The second inscription is found on one of the lintels covering the eastern passage, marked B on Fig. 1. When first observed, four of the characters and part of a fifth were hidden under the face of the stone, where it lay bedded on the southern jamb of the passage; and it was not until it was raised, and turned on its side, that they were, for the first time since the construction of the cave, offered to human observation. The appearance of the sculpture seems to indicate long exposure to the weather prior to the deposit of the stone; and goes to support the conjecture suggested by the ribbed appearance in the other, that both these lintels may have been monumental pillar-stones, brought not improbably from the adjoining cemetery of Relig-na-Ree. The inscription consists of eight characters, two of which stand somewhat detached, yet seem to require collocation with the others to render an articulate sound.

Fig. 7.



The Key-word MAQI does not exist here to assist us; but a curved character occurring near the end of the group indicates that it is to be deemed under the stem-line, and that consequently the detached characters above referred to are those from which the reading commences. The writer is not aware of any other example of the curved character in any existing monument; but it is one of the contractions given in the recognised Ogham keys, having the value of the vowels UI. The last character to the right is extremely faint, and the writer is unable to say with certainty whether it consists of three or of two indentations. It appeared, however, to the eye and touch rather to consist of three strokes and these below the stem-line; but as F would not articulate with the next adjoining character (M), and the strokes are short and notch-like, he inclines to suppose it the vowel U, a not unfrequent termination of proper names in Oghamic writing. Taken in this sequence, the legend on this second stone would read

QRAGUISMU.

The writer is not aware at present of any corresponding proper name. Names beginning with the same combination are, however, found on some of the inscribed stones in the Academy's collection, as

QRITTALEGI QRITUMAH,

on stone, No. 5. In the absence of anything more satisfactory we can, therefore, conclude no more from this object, than that Ogham writing was certainly in use prior to the construction of the Cave of Curachain.

But, as regards the lintel first described, the legend of "The Son of Medf" appears to stand plainly legible, according to the ordinary key, and in the ordinary course of collocation; and, taken in connexion with the place and its traditions, may afford a confirmation of the testimony of our old books to the use of alphabetic writing in the Ogham character at a period before the introduction of Christianity.

On the seemingly Latinized form of the inflections, and the feminine genitive in *i*, the writer desires to submit the matter to more competent philologists; and, with regard to the probable age of the cave, and the appearance it presents of having had two entrances, refers to Keating's tract on "Early Irish Modes of Sepulture," from the *Tri Biorr-ghaethe an Bhais* ("Irish Ossianic Society's Transactions," vol. i., p. 63, *et seq.*) and in particular to the old poem there cited :*—

Feart aen dorus d'fior go naoi,
Feart go n-dó ḋóirriḃ do mnaoi.

A grave of one door for a man of science;
A grave of *two doors* for a woman.

XV.—REPORT ON THE PROGRESS MADE IN COLLECTING THE IRISH LICHENS, ACCOMPANYING A PRESENTATION TO THE NATURAL HISTORY SOCIETY OF A COMPLETE SERIES OF SPECIMENS OF THOSE HITHERTO COLLECTED; WITH AN ANNOTATED LIST THEREOF, ALPHABETICALLY ARRANGED, AND AN INDEX-LIST TO THE COLLECTION IN THE ORDER IN WHICH THE SPECIES OCCUR THEREIN. By Admiral THEOBALD JONES, F. L. S., F. G. S.

[Read before the Natural History Society of Dublin, May 6, 1864.]

SOME time ago, having been requested by the Dublin University Natural Science Association to collect and record the Irish Lichens, I undertook to do so, and the present Collection is the result of my labours hitherto. But, since then, that Association having become united with this Society, I have great pleasure in handing over the Collection herewith to the joint Society. It consists of 349 specimens, gummed to sheets of paper, in four fasciculi. The specimens are not arranged in any definite order. To each Lichen is appended a number referring to an accompanying separate manuscript catalogue for each fasciculus, and in which are duly recorded the names of the plants, the locality where each is gathered, and by whom, and often additional original remarks. Such of the specimens as I supposed to be new were sent to Dr. Nylander, and were named by him; with the assistance of Mr. Carroll, I have as far as possible named the remainder; but it is to be observed that several specimens, though referred to their proper genera, are not specifically named. Some of these obscure forms proved on further examination to be known Lichens, and, though duplicates, were permitted to remain in the collection, rather than by their removal derange the distinguishing numbers of it.

Sixty-four of these Lichens are not found in the "Flora Hibernica," and it may be supposed that Dr. Taylor did not claim them as Irish Lichens; on the other hand, a considerable number of the species recorded by Drs. Taylor and Mackay in the "Flora Hibernica" are not found in this Collection, and it is to be hoped that younger and more active lichenists will soon make good these deficiencies.

There are amongst these Lichens six new species; these have been named by Dr. Nylander; but they are not as yet published. I hope, however, that the descriptions of them will appear during this year in the "Flora" published by the Royal Botanical Society of Regensburg.

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* Since making the above communication, the writer has been informed by Richard R. Brash, Esq., Sunday's Well, Cork, that Mr. Brash, accompanied by J. Windele, Esq., Cork, observed the Ogham inscription on the stone marked A, on a visit to Rathcroghan in the year 1852.

With this Collection I have the pleasure likewise to present to the Society a copy of Mudd's "Manual of British Lichens." This is the latest work on English Lichens. I do not myself adopt its nomenclature, but have often referred to it whilst naming these Lichens. Mr. Mudd has devoted much labour to it, and to the inquiring lichenist its copious synonyms and references must be found very useful. But I think it necessary to say that I cannot accept Mr. Mudd's measurements of spores. Moreover, the paragraph relating to the measurement of spores, at page v. of the Introduction, seems to me especially obscure. In my own experience I have never met with the spore of a Lichen in length ·01 of an English inch; but, according to Mr. Mudd, spores of this size are of common occurrence—nay, he even gives the spores of *Pertusaria velata** as ·05 to ·06 of an inch in length. It will therefore be found, where I have given the measurements of the spores, that those measurements will not coincide with those recorded for the species in Mr. Mudd's work.

In handing over this Collection to the Society, I would only stipulate that any specimen should not, by those who may consult it, be cut up or mutilated; and I trust that it will receive fresh accessions, with a view to filling up the desiderata, at the hands of the members, towards which my own future exertions shall not be wanting.

In the accompanying List the number prefixed to each name is that borne by the representative specimen in the Collection, and the initials appended after the locality are those of the collector. An asterisk (*) is prefixed to those species which are new to Ireland,—that is to say, those which are not recorded in Dr. Mackay's "Flora Hibernica."

The following is the List of Lichens in the Collection now presented to the Society, the Genera and Species being, for facility of reference, respectively arranged alphabetically:—

ABROTHALLUS (*De Not.*).

*No. 76.—Abrothallus Smithii (*Tulasne*). Near Roundwood. T. J.

ALECTORIA (*Ach.*).

No. 306.—Alectoria jubata (*Linn.*). Luggelaw. T. J.

This is the form which grows on rocks; it is rigid, and is not appressed; it is the form by some (erroneously) called *bicolor*.

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* "Manual of British Lichens," p. 274.

ARTHONIA (*Ach.*).

No. 283.—Arthonia astroidea (*Ach.*). Castle Barnard. T. J.

Nos. 140 and 193.—Arthonia cinnabarina (*T. and B.*). Borris, Co. Carlow. T. J.

No. 259.—Arthonia epipasta (*Ach.*). Glengariff. T. J.

Mr. Carroll thinks *A. astroidea*, var. *epipastoides*.

No. 261.—Arthonia ilicina (*Tayl.*). Glengariff. T. J.

BÆOMYCES (*Pers.*).

No. 31.—Bæomyces rufus (*Wahlb.*). Rocks south of Woburn, Co. Down. T. J.

No. 178.—Mount Leinster, Co. Carlow. T. J.

I have placed the plant Mr. Moore thought *roseus* here (No. 31), as I doubted his name. Mr. Carroll agrees with me.

CALICIUM (*Pers.*)

*No. 266.—Calicium tympanellum (*Ach.*). Curraghmore. T. J.

CETRARIA (*Ach.*).

No. 307.—Cetraria glauca (*Ach.*). Shore of Lough Tay, Co. Wicklow. T. J.

CLADONIA (*Hoffm.*).

No. 35.—Cladonia coccifera (*Ach.*). Rocks south of Woburn, Co. Down. T. J.

Nearest to Mudd's No. 23; pronounced *macilenta*, var. *carcata* (Ach.) by Nylander; but the specimen does not accord with Mudd's *bellidiflora*, nor with Rabenhorst's No. 310.

No. 199.—Curraghmore. T. J.

No. 200.—Cladonia coccifera macilenta (*Hoffm.*), filiformis (*Relh.*). Curraghmore. T. J.

No. 225.—Cladonia endiviæfolia (*Fries*). Glengariff. T. J.

No. 57.—Killarney. D. M.

Perhaps connected with *endiviæfolia*.

No. 40.—Cladonia furcata (*Fries*); *var.* pungens, (*Ach.*). Rocks south of Woburn, Co. Down. T. J.

No. 226.—Glengariff, Co. Cork. T. J.

No. 40 resembles Mudd's No. 16, which Nylander pronounces as above. See also Rabenhorst, No. 277.

No. 262.—Cladonia macilenta (*Hoffm.*). Glengariff. T. J.
No. 302.—Cladonia papillaria (*Hoffm.*). Howth. T. J.
No. 137.—Cladonia? pyxidata (*Fr.*). Sheepwalk, Armagh. T. J.
No. 131.—Cladonia squamosa (*Hoffm.*). Sheepwalk, Armagh. T. J.
No. 263.—Cladonia uncialis (*Hoffm.*). Mangerton. T. J.

COLLEMA (*Homff.*).

No. 38.—Collema cheileum (*Ach.*). Rocks south of Woburn, Co. Down. T. J.
No. 134.—Collema ? cristatum (*Leight.*). Sheepwalk, Armagh. T. J.

I supposed this *C. limosum* (Nyl.); Mr. Carroll thinks it *C. cristatum* (Leight.) form? and Nylander,* pronounces the plant of Leighton, *C. crispum*.

No. 270.—Collema? flaccidum (*Ach.*). Curraghmore. T. J.
No. 143.—Collema? furvum (*Ach.*). Sheepwalk, Armagh. T. J.
No. 146.—Collema melænum (*Ach.*). Sheepwalk, Armagh. T. J.

Mr. Carroll thinks rather *C. cristatum* (Leight.).

*No. 244.—Collema multipartitum (*Sm.*). Dunkerron, and on Muckross demesne walls. T. J.
No. 125.—Collema pulposum (*Ach.*). Sheepwalk, Armagh. T. J.
No. 279.—Collema ——— ? Dunkerron. T. J.

Though there be similarity of appearance between this and No. 270, they are different plants: when moist, this swells and thickens; No. 207 continues thin; unfortunately, neither plant is fruited. The affinity of No. 270 is with *Collema flaccidum* (*Ach.*).†

No. 145.—Collema ——— ? Sheepwalk. Armagh. T. J.
No. 62.—Collema ——— ? Glengariff, near the sea. D. M.

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* "Synopsis Lichenum," p. 110.

† *See* Nylander, ibid., p. 107.

ENDOCARPON (*Hedw.*).

No. 67.—Endocarpon fluviatile (*DC.*). Lough Tay, Co. Wicklow. T. J.

No. 65.—Endocarpon miniatum (*Ach.*). Kilkenny. T. J.

No. 66.—Endocarpon miniatum, *var.* complicatum (*Ach.*). Killiney. T. J.

EPHEBE (*Fries*).

No. 343.—Ephebe pubescens (*Fr.*). Dublin mountains. T. J.

The fruit of this plant was first noticed in Ireland by Mr. Archer, who gave me specimens for examination. So long as there is a superabundant supply of moisture, the plant does not fruit. Search a sloping rock which dries quickly after every shower, and you will find the fruit. I have so arranged the specimen, that without moistening it, the plant and the exterior of both forms of the fruit may be seen with the pocket lens.

EVERNIA (*Ach.*).

No. 202.—Evernia prunastri (*Ach.*). Curraghmore. T. J.

GRAPHIS (*Ach.*).

*No. 273.—Graphis anguina (*Mont.*). Curraghmore. T. J.

This is not the pulverulent form, No. 10 of Carroll's Lichens; there is also a slight difference in the arrangement of the apothecia (Lirellæ), but internally the plants correspond. The spore is several-septate and muriform, ·00165′ by ·0006″. Nylander,* says *G. anguina* (Mont.) and *G. scripta* (Ach.) differ only by the form of their spores. Iodine, however, exhibits another striking difference. Treated with iodine, the spores, in all the forms of *G. anguina* I have examined, become dark indigo-blue, whilst the hymenium gelatine is little, if at all, affected.

No. 201.—Graphis dentritica (*Ach.*). Curraghmore. T. J.

*No. 97.—Graphis elegans (*Ach.*). Demesne, Armagh. T. J.

No. 278.—Glengariff. T. J.

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* "Prodromus," p. 149.

No. 132.—Graphis inusta (*Ach.*), G. Smithii, *var.* divaricata (*Leight.*). Demesne, Armagh. T. J.

*No. 219.—Graphis Lyellii (*Sm.*). Castle Barnard, Co. Cork. T. J.

No. 141.—Graphis scripta (*Ach.*, *Nyl.*), G. serpentina (*Leight.*). Demesne, Armagh. T. J.

No. 83.—Graphis Smithii, *var.* macularis (*Leight.*). Demesne, Armagh. T. J.

GYALECTA (*Ach.*).

No. 113.—Gyalecta exanthematica (*Sm.*). Sheepwalk, Armagh. T. J. Lecidea by Nylander.

No. 245.—Gyalecta truncigena (*Ach.*). Curraghmore and Cork. T. J.

The spores are long, and do not correspond with Mudd's description.* His No. 140 is really *G. Flotowii*, of which I have an authentic specimen.

GYROPHORA (*Ach.*).

No. 349.—Gyrophora erosa (*Web.*). Slieve Cor, Co. Mayo. D. M.

This is a state; the difference is in colour; the plant is not fruited. This plant is pale, livid, smooth on the under side; but I think it correctly named.

*No. 308.—Gyrophora polyphylla (*Linn.*). Shore of Lough Tay. T. J.

LECANORA (*Ach.*).

*No. 315.—Lecanora albariella (*Nyl.*). Glenarm; rocks, sea shore, but not covered by the tide. T. J.

No. 70.—Lecanora albella (*Ach.*). Learmount, Co. Derry. T. J.

Too near *L. subfusca.*

No. 157.—Demesne, Armagh.
No. 233.—Castle Barnard, Co. Cork. T. J.

No. 1.—Lecanora atra (*Ach.*). Barclay's Rock, Woburn, Co. Down T. J.

Both forms of fructification.

No. 284.—Lecanora atra? Barclay's Rock, Co. Down. T. J.

Form—As this plant has Spermatia arcuate, it cannot be any form of *Lecanora atra.*

No. 303.—Lecanora atrocinerea (*Dicks.*). Luggelaw. T. J.

This is a form of *L. sophodes.*

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* "Manual," pag. 167.

No. 160.—Lecanora aurantiaca. Form. Demesne, Armagh, on young trees. T. J.

Mr. Carroll thinks No. 160 a variety of *L. cerina.*

No. 296.—Curraghmore. T. J.

No. 296 is probably the form named *Callopisma ulmicola* by Mudd; *ulmicola* of Leighton and Hepp. On the specimen is a form of *Lecanora subfusca,* and a parasite (I think fungoid) with 3-septate pale brown spores.

No. 127.—Lecanora aurantiaca, *var.* erythrella (*Ach.*). Sheepwalk, Armagh. T. J.

This plant and No. 126 are relatives by spores. This plant when fresh has more the aspect of Placodium; it is probably *Lecanora aurantiaca,* with *Lecidean* fruit, however.

*No. 180.—Lecanora badia (*Ach.*). Mount Leinster. T. J.

No. 139.—Lecanora (Urceolaria) calcarea (*Ach.*). Ballymoon, Co. Carlow. T. J.

No. 183.—Lecanora (Urceolaria) calcarea (*Ach.*), *var.* contorta (*Flk.*). Ballymoon, Co. Carlow. T. J.

No. 110.—Lecanora cerina (*Ach.*). Demesne, Armagh, on young trees. T. J.

There are other Lichens here, one of them *L. subfusca*—form with 16 spores; but I do not notice them here; they cannot be confused with *L. cerina.*

No. 181.—Lecanora cervina (*Schrad. Pers.*). Mount Leinster. T. J.

No. 28.—Form. Rocks south of Woburn.

No. 48.—Lecanora cinerea (*Linn. Nyl.*). Barclay's Rock, Co. Down. T. J.

Nylander considers the plant heretofore known as *Urceolaria cinerea* (*Ach.*) as properly a Lecanora.

No. 289.—Lecanora coarctata (*Ach.*). Barclay's Rock, Co. Down. T. J.

No. 74.—Learmount, Co. Derry.

I observe the fructification (No. 289) is lost; but there was fruit, and I referred the plant when gathered to the form *ornata.*

No 75.—Lecanora coarctata (*Ach.*), perhaps L. ornata (*Smfl.*). Learmount, Co. Derry. T. J.

*No. 287.—Lecanora erysibe (*Ach.*). Barclay's Rock, Co. Down. T. J.

No. 15.—Lecanora glaucoma (*Hoffm.*). Barclay's Rock, Co. Down. T. J.

No. 232.—Lecanora hæmatomma (*Ach.*). On trees, and fruited. Castle Barnard, Co. Cork. T. J.

No. 280.—Glengariff. T. J.

No. 37.—Lecanora parella (*Ach.*). Rocks south of Woburn, Co. Down. T. J.

No. 116.—On trees. Armagh Demesne. T. J.

No. 45.—Lecanora sophodes (*Ach.*). Barclay's Rock, Co. Down.

No. 95.—Sheepwalk, Armagh.

Mr. Mudd* pronounces that the true *L. sophodes* (Ach.) has sixteen spores, and that the forms with only eight spores belong to *L. exigua.* He refers to Schœrer's No. 314 in support of this; but in my copy of Schærer No. 314 has only eight spores in each ascus.

Lecanora sophodes will appear often, such are the different aspects of its thallus.

No. 96.—Lecanora sophodes (*Ach.*), *var.* roboris (*Duf.*). On trees, Curraghmore. T. J.

No. 333.—On old oak.

No. 333 named by Nylander.

No. 18.—Lecanora subfusca (*Ach.*), *var.* Barclay's Rock, Co. Down. T. J.

This form of *L. subfusca* is abundant south of the coastguard station. It cannot be referred to any of the named varieties of this polymorphous plant.

No. 110.—Armagh. T. J.

No. 41.—Lecanora subfusca (*Ach.*), *var.* Barclay's Rock, Co. Down. T. J.

Mr. Carroll thinks this form merits the name *pannarioides.*

No. 82.—Demesne, Armagh. T. J.

Mr. Carroll thinks the plant (overrun by a parasite, Sphæria) a Verrucaria. It is pretty general both on trees and on the same Lecanora on rocks by the sea shore.

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* "Manual," p. 142.

No. 164.—Demesne, Armagh. T. J.

Accompanied by a parasite, probably fungoid.

No. 256.—Near Blackwater Bridge. T. J.

The thallus spreads on the under side of the ledges of rocks to a great extent, rarely perfecting its fruit; but this form of *L. subfusca* is not recorded.

No. 274.—Barclay's Rocks, Co. Down. T. J.

Lecanora subfusca, var. *pannaroides* (Carroll). *Vide* Carroll's MSS.; also No. 41.

No. 290.—Barclay's Rock, Co. Down. T. J.

No. 292.—Barclay's Rock, Co. Down. T. J.

The thallus of *Lecanora subfusca* is peculiar. The accompanying Verrucaria Mr. Carroll thinks may be a *saxicole* form of *V. rhyponta* (Ach.).

No. 297.—Lecanora sulphurea (*Hoffm., Massal.*). Killiney. T. J

No. 295.—Lecanora tartarea (*Linn.*). Killiney. T. J.

Second form of fructification only.

No. 305.—Luggelaw. T. J.

Fruited. *See* No. 295.

*No. 218.—Lecanora Turneri (*Sm.*). Muckross Demesne. T. J.

Very near *L. parella*; but on old trees, and very constant to its form.

No. 172.—Lecanora varia. (*Ach.*). Form. Demesne, Armagh. T. J.

The principal Lichen on No. 172 is a Lecanora, with purple disk; its appearance more that of *atra* than of *subfusca*; but the object was the Opegrapha having both forms of fructification; it proves a form of *O. varia.*

No. 234.—Form. Castle Barnard. T. J.

Mr. Carroll thinks *L. orosthea.*

*No. 316.—Lecanora varia, *var.* intricata (*Ach.*). Tower Hill, Curraghmore. T. J.

Both forms of fructification. Named by Nylander.

No. 107.—Lecanora ventosa (*Ach.*). Croaghan, Co. Donegal. T. J. Both forms of fructification.

No. 321.—Lecanora ——— ? Tower Hill, Curraghmore. T. J. *See* my 1571.

Perhaps, though varying in colour of Apothecium, not distinct from No. 316, *ante*.

LECIDEA (*Ach.*).

No. 265.—Lecidea abietina (*Nyl.*). Curraghmore. T. J.

Showing second form of fructification. Though this second form of fructification is plentiful at Curraghmore, apothecia are not formed; so large are the spermatia, that, unless both forms are seen together, one could scarcely believe they belonged to one and the same plant. This is Pyrenothea of authors.

No. 105.—Lecidea albo-atra (*Hoffm.*). Demesne, Armagh, on young trees. T. J.

No. 3.—Lecidea aromatica (*Turn.*). Lime-capped wall, Woburn, Co. Down. T. J.

No. 128.—Sheepwalk, Armagh. T. J.

In the latter locality *L. aromatica* places itself on the thallus of *Collema nigrum* (Huds.).

*No. 87.—Lecidea atro-grisea (*Delise.*). Demesne, Armagh. T. J.

No. 114 & 11.—Demesne, Armagh. T. J.

No. 114 is taken as a *form*, on account of the colour of its young apothecia; it always remains unlike in aspect to No. 87. *See* also No. 117.

No. 117.—Demesne, Armagh. T. J.

*No. 185.—Lecidea atro-sanguinea (*Hoffm.*). Curraghmore. T. J.

No. 4.—Lecidea aurantiaca (*Lightf.*). Lime-capped walls, Woburn, Co. Down; and sheepwalk, Armagh. T. J.

Mr. Carroll thinks this is a form; the typical plant is doubtless on trees; but in essentials I do not find any tangible difference. The paraphyses are septate, sparingly branched, sometimes compound—that is, many-headed; in general the apothecium is at first enclosed; this is not the case here.

No. 288.—Lecidea ? aurantiaca (*Leight.*). Sheepwalk, Armagh. T. J.

Mr. Carroll thinks may be ***Callopisma ochraceum*** (Mudd), which he considers a var. of *Lecanora aurantiaca*. This plant belongs to Massalongo's Blastiniospori. It is a Lecidea from the beginning.

*No. 174.—Lecidea bacillifera (*Nyl.*). Sheepwalk, mouth of the cave. T. J.

Nylander's habitat is on wood, and this is on stone.* I do not attach any value to that; but the thallus is different; the colour of the apothecia different. Iodine causes blue, which partially becomes sordid; and the plant must be considered a form of *Lecidea bacillifera* (Nyl.). The spores of this plant are 3-septate, and measure ·00055″ to ·0007″ by ·00008″ to ·0001″. Paraphyses, subconglutinate; hypothecium pale.

Nylander has seen this plant, and has named it.

No. 187.—Lecidea calcarea (*Weiss*). Near Ballymoon, Co. Carlow. T. J.

This Lecidea has been named *L. umbilicata* (Ram.). ***Pannaria nigra*** also occurs.

*No. 168.—Lecidea calcivora (*Nyl.*), Lecidea immersa (*Sm.*). Sheepwalk, Armagh. T. J.

No. 276.—Lecidea (Placodium) canescens (*Ach.*). Near Cork. T. J.

Fruited. A common plant, but rarely fruited in Ireland.

No. 177.—Lecidea chalybeia (*Borr.*) Sheepwalk, Armagh. T. J.

No. 10.—Lecidea coniops (*Wahlb.*). Barclay's Rock, Co. Down. T. J.

No. 21.—Lecidea contigua (*Fr.*). Woburn, Co. Down. T. J.

No. 182.—Mount Leinster. T. J.

An old plant.

*No. 71.—Lecidea disciformis (*Fr.*). Howth, close to the sea. T. J.

No. 104.—Curraghmore. T. J.

No. 104 corresponds with *L. disciformis* in essentials; but it is not the usual appearance of the plant; both forms of fructification.

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* "Lichen. Scand.," p. 240.

No. 278.—Glengariff. T. J.
No. 286.—Killiney. T. J.

With both forms of fructification.

No. 293.—Curraghmore. T. J.

L. disciformis with both forms of fructification; a mixture of Lichens.

No. 13.—Lecidea ferruginea (*Huds.*). Barclay's Rock, Co. Down. T. J.
No. 44.—Barclay's Rock, Co. Down, is a poor and imperfect form.
No. 109.—Curraghmore. T. J.

*No. 319.—Lecidea fusco-rubens (*Nyl.*). Glenarm, on chalk. T. J.

*No. 269.—Lecidea grossa (*Pers.*). Curraghmore. T. J.

No. 348.—Lecidea incana (T. & B.), = L. pachycarpa (*Duf.*). Cromagloun, Co. Kerry. D. M.

The apothecia are perfect, but the specimen has suffered in carriage, and the thallus, mixed with other Lichens, is not satisfactorily exhibited. The fructification is rare.

*No. 248.—Lecidea inspersa (*Tulasne*). Curraghmore. T. J.

Parasitic on *Pertusaria fallax.*

*No. 29.—Lecidea lenticularis (*Ach.*). Rocks south of Woburn, Co. Down.
No. 149.—Sheepwalk, Armagh. T. J.
Nos. 177.—Sheepwalk, Armagh. T. J.
No. 290.—Barclay's Rock, Co. Down. T. J.

*No. 155.—Lecidea Lightfootii (*Ach.*). Demesne, Armagh. T. J.
No. 314.—Form. Curraghmore, on cork-tree. T. J.

*No. 252.—Lecidea lutea (*Dicks.*). Cork and Luggelaw. T. J.

No. 103.—Lecidea luteola, *var.* rubella (*Ach.*). On very old oak, Curraghmore. T. J.

*No. 175.—Lecidea lutiella (*Nyl.*). Sheepwalk, mouth of the cave. T. J.

New species named by Nylander. Spores 1-septate ·0006″ by ·0002″; paraphyses lax, hypothecia pale; with iodine cærulescent, and partially obscure, blue and yellow.

*No. 249.—Lecidea mutabilis (*Fée*). Castle Barnard. T. J.

With second form of fructification.

No. 32.—Lecidea myriocarpa (*DC.*), and L. vermifera (*Nyl.*). Rocks south of Woburn, Co. Down. T. J.

See No. 27.—I notice *L. vermifera* here, as its thallus is dull olive-green.

No. 169.—Curraghmore. T. J.
No. 294.—Barclay's Rock. A mixture of Lichens. T. J.

No. 162.—Lecidea parasema (*Ach.*). Demesne, Armagh. On old laurel. T. J.
No. 188 & 189.—*L. parasema* and *Verrucaria biformis*, mixed. Ballymoon, Co. Carlow. T. J.
No. 195.—*L. parasema*, var. *saxicola*. Borris, Co. Carlow. T. J.

No. 86.—Lecidea petræa (*Flot.*) Woburn, Co. Down. T. J.
No. 298.—Barclay's Rock, Co. Down. T. J.

*No. 102.—Lecidea pineti (*Ach*). Demesne, Armagh. Overrunning Jungermannia on birch bark. T. J.

No. 111.—Lecidea premnea (*Fries*). Curraghmore. T. J.
No. 250.—Curraghmore. T. J.
No. 268.—Castle Barnard. T. J.

No. 285.—Lecidea quadricolor (*Dicks.*), decolorans (*Flk.*). Dublin mountains. T. J.

No. 264.—Lecidea quernea (*Ach.*). Curraghmore. T. J.
No. 267.—Curraghmore, Castle Barnard. T. J.

More perfect.

No. 186.—Lecidea rivulosa (*Ach.*). Curraghmore. T. J.
No. 20.—Lecidea rupestris (*Ach.*). Woburn, Co. Down. T. J.
*No. 176.—Lecidea sphæroides (*Sommrf.*). Florence Court. On an old ash tree. T. J.

No. 19.—Lecidea stellulata (*Tayl.*); also L. myriocarpa, saxicola. Barclay's Rock, Co. Down. T. J.
No. 47.—Barclay's Rock, Co. Down. T. J.
No. 188.—*Lichen verrucosus* (*E. B.* 2317). Near Ballymoon, Co. Carlow. T. J.

There are three Lichens in this specimen, *L. stellulata* (Tayl.), *Lecidea parasema* (Ach.), and *Verrucaria Dufourei* (*DC.*)

*No. 247.—Lecidea sublurida (*Nyl.*). Glengariff. T. J.
No. 281.—Glengariff. T. J.

No. 49.—Lecidea sulphurea (*Ach.*). Barclay's Rock, Co. Down; also *L. stellulata*. J. T.

No. 84.—Lecidea Templetoni (*Tayl.*). Sheepwalk, Armagh.

Mr. Carroll thinks this not true *L. Templetoni*, but rather *L. atrofusea* (Hepp.). I have retained the name, as the spores are 2–3–septate, broader at one end, round at the ends, ·00066″ by ·0002″—very different in appearance from any variety of *L. vernalis*.

No. 73.—Lecidea uliginosa (*Schrad.*). Dublin mountains. T. J.

*No. 27.—Lecidea (Scoliciosporum) vermifera (*Nyl.*), now by Nylander named Lecidea umbrina (*Ach.*). Barclay's Rock, Co. Down; rocks south Woburn. T. J.

No. 32.—Woburn, Co. Down. T. J. *L. myriocarpa* also on this specimen.

No. 34.—A confused mixture. Rocks south of Woburn, Co. Down. T. J.

The Scoliciosporum (on No. 34) only is noticed; its thallus differs apparently from the more usual form. The plant is now by Nylander named *L. umbrina* (*Ach.*).

No. 179.—Mount Leinster. T. J.

The thallus is mixed, and encumbered by algæ, and the plant is not easily recognised; but it is by the spores certainly *L. vermifera*, now *L. umbrina* (Ach.) by Nylander.

No. 77.—Lecidea vernalis (*Ach.*). By the shore of Lough Dan, Co. Wicklow. T. J.

A varying plant (see also No. 92); the spores 3–6–sept. in length from ·0004″ to ·0012″.

No. 92.—Sheepwalk, Armagh. T. J.

No. 120.—Lecidea ——— ? Demesne, Armagh. T. J.

This Lichen never forms spores. Mr. Carroll thinks it is a state of *Lecanora ferruginea*.

No. 191.—Lecidea ——— ? Near Ballymoon, Co. Carlow. T. J.

Supposed form of *L. contigua*.

No. 224.—Lecidea? and Phlyctis agelæa (*Ach.*). Castle Barnard, Co. Cork. T. J.

This Lecidea is allied to *L. Lightfootii* and *L. flexuosa.*

LEPTOGIUM (*Fries*).

No. 56.—Leptogium Burgessii (*Lightf.*). Killarney. D. M.
No. 53.—Leptogium lacerum (*Swartz*). Woburn, Co. Down. T. J.
No. 142.—Var. Sheepwalk, Armagh.

Mr. Carroll thinks this not different from No. 53.

No. 332.—Leptogium? palmatum (*Ach.*). Shore of Lough Tay, Co. Wicklow. T. J.

As this Leptogium flourishes on moss-covered stones under water, except during the summer months, it was sent to Dr. Nylander. Dr. Moore first observed the plant. Of it Dr. Nylander says—"Leptogium palmatum, ut videtur, sed sterile, inde haud omnino certum."

*No. 147.—Leptogium Schraderi (*Bernh.*). Fruited. Sheepwalk, Armagh. J. T.
No. 153.—Leptogium? scotinum (*Ach.*). Sheepwalk, Armagh. T. J.
No. 136.—Leptogium? tenuissimum? (*Kbr.*). Woburn, Co. Down. T. J.
*No. 243.—Leptogium tremelloides (*Ach.*). Old Dromore. T. J.
No. 64.—Leptogium? On trees, Glengariff. D. M.

Certainly a new plant, but unfortunately not fruited. Dr. Hepp considers it a Leptogium, and has named it *L. Moorii.* Dr. Moore had previously called it *Leptogium anomalum.**

No. 184.—Leptogium ——? Ballymoon, Co. Carlow. T. J.

This is not fruited; it spreads over stones to a considerable extent, and forms a dense coat, like plush, the little stems being nearly upright.

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* "Proceedings of the Dublin University Zoological and Botanical Association," vol. ii., Part II. (April, 1863), p. 87.

LICHINA (*Ag.*).

No. 7.—Lichina confinis (*Ag.*). Barclay's Rock, Co. Down. T. J.

Both forms.

No. 8.—Lichina pygmæa (*Ag.*). Barclay's Rock, Woburn, Co. Down. T. J.

Both forms, but spores not satisfactorily seen.

MELANOTHECA (*Fée*).

*No. 258.—Melanotheca gelatinosa (*Chev.*).

Mudd gives this plant (see his Sp. No. 232) as *Arthonia punctiformis*, v. *olivacea* of Ach. I have ascertained its name through Nylander.

MYRIOSPORA (*Hepp*).

*No. 173.—Myriospora Heppii (*Näg.*).—Sheepwalk, Armagh. J. T.

This plant continues to the end in form a Gyalecta, having spores numerous; on which account, perhaps, it has been referred by authors to *Lecanora cervina.* As I have found this form in Kent, I use Nägeli's name.*

NEPHROMA (*Ach.*).

*No. 242.—Nephroma lævigatum (*Ach.*). Old Dromore. T. J.

No. 309.—Lough Tay, Co. Wicklow. T. J.

This is a remarkable form. It covers the stones still washed by the water in summer, and must in winter be three feet under water. As it never fruits, a doubt may remain as to the genus. In its fresh state, the yellow colour of the interior of the thallus is decided and distinct, and no doubt it is the form referred to by Nylander.†

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* *See* "Lich. Scand.," p. 174; Mudd's "Manual," p. 160.

† "Synopsis Lichenum," p. 320 (note).

OPEGRAPHA (*Humb.*).

No. 144.—Opegrapha atra (*Pers.*). Demesne, Armagh. T. J.

A state.

No. 159.—Demesne, Armagh. T. J.
No. 171.—Demesne, Armagh. T. J.

No. 282.—Opegrapha atra, *var.* paralella (*Leight.*). Castle Barnard. T. J.

No. 12.—Opegrapha Chevalieri (*Leight.*). Barclay's Rock, Co. Down. T. J.

No. 112.—Opegrapha epiphega (*Ach.*). Curraghmore. T. J.

It seems generally agreed that this plant is not a true Lichen; there are no gonidia; both forms of fructification are present. The plant in its young state exteriorly resembles Hysterium.

*No. 342.—Opegrapha herpetica (*Ach.*). Demesne, Armagh. On birch. T. J.

See 206. This plant was named by Mr. Carroll.

*No. 235.—Opegrapha involuta (*Wallr.*). Castle Barnard. T. J.

Named by Nylander.*

No. 340.—Opegrapha Persoonii (*Ach.*). On rocks, Sheepwalk, Armagh. T. J.

See my Nos. 1232, 1591.

No. 166.—Opegrapha rupestris (*Pers.*). Sheepwalk, Armagh. T. J.
No. 341.—Glenarm, on chalk rock. T. J.

See No. 1548. There are slight external differences between this and the last plant; but they must be taken as forms of the same plant.

No. 89.—Opegrapha varia (*Pers.*). Demesne, Armagh. T. J.
No. 99.—Form. Demesne, Armagh. T. J.

These two pieces (No. 99) have on them a mixture of Lichens; two of Opegrapha—*O. varia* and *O. herpetica*, and second forms of fructification; but all mixed and confused. *O. varia* is the object, and it is best displayed in the smaller piece.

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* *See* Körber, p. 286.

No. 115.—Demesne, Armagh. Form. T. J.
No. 172.—Demesne, Armagh. T. J.

There being two Lichens on the specimen, and the Opegrapha (the object) being the least conspicuous, this note seemed necessary. The Lecanora is only secondary; moreover, it is of doubtful form.

No. 275.—Castle Barnard. T. J.

No. 338.—Opegrapha varia, *var.* diaphora (*Ach.*). Glenarm, on chalk rock. T. J.

Dr. Nylander names this plant as above; he refers to "Lich. Scand.," p. 253. Form on rocks.

No. 129.—Opegrapha vulgata (*Ach.*). Armagh Demesne. T. J.
No. 277.—Glengariff. T. J.

No. 277 shows both forms of fructification.

PANNARIA (*Delise.*)

*No. 347.—Pannaria cheilea (*Nyl.*). Rocks by the sea shore, Blackwater Bridge, Co. Kerry. T. J.

Mr. Mudd prefers Körber's genus "Massolongia."* I may be allowed to say that I better understand and prefer Dr. Nylander's naming.

No. 165.—Pannaria microphylla (*Sm.*, *Massal.*). Killarney. D. M.
Sterile.

*No. 300.—Pannaria muscorum (*Del.*, *Ach.*), *var.* determinata (*Nyl.*) Dublin mountains. T. J.

No. 152.—Pannaria nigra (*Huds.*). Sheepwalk, Armagh. T. J.

I use Nylander's name.†

No. 231.—Pannaria plumbea (*Delise*). Old Dromore. Co. Cork. T. J.
No. 61.—Pannaria rubiginosa (*Thunb.*). Killarney. D. M.
*No. 323.—Pannaria triptophylla (*Ach.*). Curraghmore, on ash. T. J.

Named by Nylander. Not fruited.

No. 324.—Pannaria ——— ? On dark damp walls of the demesne, Castle Barnard. T. J.

A Pannaria, but of a doubtful form; not fruited.

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* *See* Mudd's "Manual," p. 126.

† *See* Nylander, "Lichen. Scand." p. 126; also Mudd's "Manual," p. 175.

PARMELIA (*Ach.*).

No. 33.—Parmelia (Physcia) aquila (*Ach.*). Barclay's Rock, Woburn, Co. Down. T. J.

Both forms of fructification.

No. 124.—Parmelia Borreri (*Turn.*). Demesne, Armagh. T. J.
No. 25.—Parmelia caperata (*Ach.*). Rocks, south of Woburn, Co. Down. T. J.
No. 88.—Parmelia conspersa (*Ach.*). Killiney. T. J.

A variety. The difference is in colour. The plant is sterile; but I think it *P. conspersa.*

No. 227.—Killiney. T. J.

No. 229.—Parmelia (Ricasolia) herbacea (*Huds., Ach.*). Old Dromore, Co. Cork. T. J.

With second form of fructification only.

No. 228.—Parmelia lævigata (*Ach.*). Glengariff. T. J.
*No. 322.—Parmelia Mougeotii (*Schær.*). Tower Hill, Curraghmore. T. J.

This plant does not fruit. It has some affinity to *P. conspersa;* but I consider it distinct.

No. 39.—Parmelia olivacea (*Ach.*) Rocks south of Woburn, Co. Down. T. J.

Variety.

No. 150.—Demesne, Armagh. T. J.

The rough form, not fruited.

No. 24.—Parmelia omphalodes (*Linn., Ach.*). Rocks south of Woburn. Co. Down. T. J.
No. 36.—Parmelia perlata (*Ach.*), *var.* ciliata (*DC.*). Rocks south of Woburn, Co. Down. T. J.
No. 123.—Form. Demesne, Armagh. T. J.
No. 230.—*Var.* ciliata (*DC.*). Old Dromore, Co. Cork. T. J.
No. 196.—Parmelia physodes (*Linn., Ach.*). Curraghmore. T. J.
No. 221.—Parmelia? pulverulenta (*Ach.*). Castle Barnard, Co. Cork. T. J.
No. 23.—Parmelia saxatilis (*Ach.*). Rocks south of Woburn, Co. Down. T. J.

It may be observed that Taylor's form *rugosa* is here on *saxatilis.*

No. 151.—Demesne, Armagh. T. J.

Mr. Carroll thinks this (No. 151) perhaps a form of *P. saxatilis.*

No. 156.—Parmelia ——— ? Demesne, Armagh. T. J.

Mr. Carroll thinks, a state of *P. obscura.*

PELTIGERA (*Willd.*).

No. 22.—Peltigera polydactyla (*Hoffm.*). Rocks south of Woburn, Co. Down. T. J.

No. 241.—Old Dromore, Co. Kerry. T. J.

PERTUSARIA (*DC.*).

No. 208.—Pertusaria communis (*DC.*). Curraghmore. T. J.

No. 209.—Curraghmore. T. J.

No. 211.—Curraghmore. T. J.

No. 212.—Curraghmore; form. T. J.

No. 213.—Pertusaria fallax (*Ach.*). Form. Curraghmore. T. J.

No. 214.—Form. Curraghmore. T. J.

Nos. 213 and 214 are imperfect forms of *P. fallax,* var. *Wulfenii, DC., fide* Nylander.

No. 205.—Pertusaria globulifera (*Hook.*). Curraghmore. T. J.

No. 210.—Curraghmore. T. J.

Though the apothecia are not present, this is the form of *Variolaria globulifera,* having a radiate border, which overruns moss and Jungermannia on trees to a wide extent.

No. 216.—Pertusaria leioplaca (*Schær.*). Curraghmore. T. J.

*No. 335.—Pertusaria nolens (*Nyl.*). Glenarm, on basalt. T. J.

See my No. 1534. In the beginning this plant may be supposed to be Urceolaria; but the *urceolarian* appearance is of short duration. There are no prominent warts, as in Pertusaria; but the nuclei are in masses, as in Pertusaria, and the openings are irregular in form; though the *urceolarian* appearance passes away, the opening of the thallus continues to show a white pulverulent margin. Interiorly the plant is altogether a Pertusaria in asci, spores, and paraphyses, eight ovate spores in each ascus, measuring

·00125″ by ·0006″, and having a thick, rounded margin; hymenium gelatine, with iodine blue.

No. 161.—Pertusaria pustulata (*Leight.*). Demesne, Armagh. T. J.

Mr. Carroll thinks this may be *P. leicoplaca*; it is very constant in its form; common in Ireland; and Leighton recognizes it, No. 230, as the plant of Acharius.

No. 170.—Curraghmore. T. J.

Mr. Carroll considers this *P. pustulata*. *See* No. 161. This plant has generally four spores in each Ascus, occasionally three or five, and they measure ·0042″ by ·0015″.

No. 217.—Curraghmore. T. J.

No. 255.—Pertusaria rupestris (*DC.*). Glengariff. T. J.

The second form of fructification fertile; verrucæ not present.

No. 206.—Pertusaria syncarpa (*Mudd*). Mountains between Old Dromore and Killarney. T. J.
No. 207.—Pertusaria ——— ? Curraghmore. T. J.
No. 215.—Pertusaria ——— ? Curraghmore. T. J.

Form known as *Variolaria faginea* (Sm.).

PHLYCTIS (*Wallr.*).

*No. 69.—Phlyctis agilæa (*Ach.*). Learmount, Co. Derry? T. J.

No. 224.—Castle Barnard, Co. Cork.

Also a Lecidea.

PHYSCIA (*Schreb.*).

No. 220.—Physcia cæsia (*Nyl.*). Rocks by sea-shore near Kenmare. T. J.
*No. 72.—Physcia candelaria (*Nyl.*). Demesne, Armagh. T. J.
*No. 90.—Physcia chrysopthalma (*Schær.*). Near Carrigaline, Co. Cork. J. C.
*No. 91.—Physcia flavicans (*Nyl.*). On maritime rocks, Whiting Bay, Co. Waterford. J. C.
*No. 299.—Physcia (Borrera) leucomela (*Schær.*). Near Cork. J. C.
No. 320.—Physcia ? lychnea (*Ach.*). Tower Hill, Curraghmore; also shore of Lough Tay, Co. Wicklow. T. J.

No. 16.—Physcia obscura, *var.* adglutinata (*Nyl.*). On old ash, Woburn, Co. Down. T. J.

No. 138.—Variety. Woburn, Co. Down. T. J.

No. 223.—Form. Castle Barnard, Co. Cork. T. J.

No. 54.—Physcia parietina (*Nyl.*). Woburn, Co. Down. T. J.

No. 158.—Form. Demesne, Armagh, on young trees. T. J.

The thallus may be seen, partially leafy at the circumference.

No. 119.—Physcia pulverulenta (*Schreb.*, *Fr.*, *Nyl.*). Demesne, Armagh. T. J.

No. 222.—Physcia stellaris (*Nyl.*). Castle Barnard, Co. Cork. T. J.

No. 327.—Physcia tenella (*Ach.*). Form. Curraghmore. T. J.

No. 148.—Physcia ——— ? Demesne, Armagh. T. J.

Two plants of Physcia, both abnormal; possibly form of *P. parietina* and of *P. pulverulenta.*

No. 317.—? Physcia ——— ? also P. parietina. Old walls near Dublin. T. J.

As this plant never fruits, it must remain doubtful; it somewhat resembles the form of *Ph. parietina lychnea* (Ach.).

No. 326.—Physcia ——— ? Form. Curraghmore, on trees. T. J.

Resembles *Ph. cæsia* and *tribacea.*

PLACODIUM (*DC.*).

No. 126.—Placodium citrinum (*Ach.*). Sheepwalk, Armagh. T. J.

Doubtless this is the plant named by Nylander* as *P. citrinum* (*Ach. Flot.*), and also by Mudd.† It is not rare; it never is true Placodium. *See* also No. 130.

No. 46.—Placodium murorum (*Hepp*). Barclay's Rock, Co. Down. T. J.

No. 130.—Placodium murorum (*DC.*) citrinum. Sheepwalk, Armagh. T. J.

See No. 126.

No. 318.—Form. Tower Hill, Curraghmore. T. J.

No. 344.—Stone walls near Dublin. T. J.

No. 345.—Stone walls near Dublin. T. J.

No. 43.—Placodium ——— ? Form. Barclay's Rock, Co. Down. T. J.

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* "Lichen. Scand.," p. 136.

† "Manual," p. 132.

RAMALINA (*Ach.*).

No. 122.—Ramalina calicaris (*Ach.*), *var.* fraxinea (*Linn.*). Demesne, Armagh. T. J.
No. 239.—Ramalina calicaris (*Fr.*), var. farinacea. Castle Barnard, Co. Cork. T. J.
No. 6.—Ramalina scopulorum (*Ach.*). Both forms. Barclay's Rock, Co. Down.
No. 30.—Form. Rocks south of Woburn, Co. Down. T. J.

RICASOLIA (*Nyl.*).

No. 229.—Ricasolia herbacea (*Ach.*). ——— T. J.
Both forms of fructification.

SPHÆROPHORON (*Pers.*).

No. 55.—Sphærophoron compressum (*Ach.*). Moist rocks, Killarney. D. M.
Fruited.
No. 26.—Sphærophoron coralloides (*Pers.*). Rocks south of Woburn, Co. Down. T. J.
No. 304.—Near Lough Bray. T. J.
Fruited.

SPHINCTRINA (*Fries.*).

*No. 108.—Sphinctrina turbinata (*De Not.*). Curraghmore. T. J.
No. 198.—Curraghmore. T. J.

SQUAMARIA (*DC.*).

*No. 246.—Squamaria gelida (*Linn.*). Glengariff. T. J.
No. 50.—Squamaria saxicola (*Ach.*). Rocks south of Woburn, Co. Down. T. J.

STEREOCAULON (*Schreb.*).

No. 81.—Stereocaulon paschale, *var.* denudatum (*Flk.*) Shores of Lough Tay, Co. Wicklow. T. J.
No. 260.—Stereocaulon paschale (*Ach.*). Glengariff. T. J.
This specimen shows that *St. denudatum* is not a good species.

STICTA (*Schreb.*).

No. 203.—Sticta fuliginosa (*Ach.*). Curraghmore. T. J.

No. 325.—Curraghmore. T. J.

I doubted whether this specimen belonged to *S. limbata* or *S. fuliginosa.* It must be admitted that the apparent difference is but small.

*No. 237.—Sticta intricata (*Del.*), *var.* Thouarsii (*Nyl.*). Fenagh, Co. Carlow. T. J.

Mr. Carroll entertains a doubt, and thinks this specimen not very expressive. It certainly varies in form from my Scotch specimens; in other respects it agrees.

No. 236.—Sticta limbata (*Ach.*). Castle Barnard, Co. Cork. T. J.

No. 301.—Sticta damæcornis (*Ach.*), *var.* macrophylla (*Hook*). Killarney. Dr. Mackay.

This is a portion of the plant first found by Mr. Wilson, and given to me, years ago, by Dr. Mackay. There is on it a small apothecium, which I leave untouched.

No. 58.—Sticta pulmonaria (*Hook.*). Killarney. D. M.

No. 197.—Sticta scrobiculata (*Ach.*). Curraghmore. T. J.

No. 240.—Sticta sylvatica (*Ach.*). Castle Barnard, Co. Cork. T. J.

STIGMATIDIUM (*Mey.*).

No. 73.—Stigmatidium crassum (*Dub.*). Learmount, Co. Derry. T. J.

No. 163.—Demesne, Armagh. T. J.

No. 204.—Curraghmore. T. J.

No. 253.—Stigmatidium Hutchinsiæ (*Nyl.*). Blackwater Bridge. T. J.

THELIDIUM (*Massal.*).

*No. 42.—Thelidium aggregatum (*Mudd*). Parasitic on *Ulceolaria calcarea* (Ach.). Form. Barclay's Rock, Co. Down.

I had considered the parasite as an undescribed Verrucaria. Mr. Mudd has referred this parasite to his genus Thelidium, adopted from Massalongo.

*No. 337.—Thelidium auruntii (*Mass.*), Thelidium immersum (*Mudd*). Glenarm, on chalk rock. T. J.

Named by Nylander. May I presume to question the reference to this plant by Mudd?

THELOTREMA (*Ach.*).

No. 59.—Thelotrema lepadinum (*Ach.*). Killarney. D. M.

UMBILICARIA (*Hoffm.*).

No. 68.—Umbilicaria pustulata (*Ach.*). Lough Dan, Co. Wicklow. T. J. Sterile.

URCEOLARIA (*Ach.*).

No. 98.—Urceolaria Acharii (*Hook.*), and a Verrucaria. Tower Hill, Curraghmore. T. J.

The old name *Ulceolaria Acharii*, by which this plant was known, must give way to *epulotica*. The plant must be called *Lecidea epulotica* (Ach.). As to the *Verrucaria*, perhaps it may belong to *V. papillosa* (Ach.). Its spores are entire.*

No. 251.—Blackwater Bridge, Co. Kerry. T. J.

See No. 98, *ante.*† *Lecanora lacustris* (Westr.), which makes it doubtful whether the plant belongs to *Lecanora lacustris* or to *Lecidea epulotica.*

No. 2.—Urceolaria calcarea (*Ach.*). Barclay's Rock, Co. Down. T. J. This is not the usual form.

No. 271.—Urceolaria calcarea (*Flk.*), *var.* contorta. Form. Curraghmore. T. J.

This spreads over an entire boulder, and so varies from the general habit.

No. 79.—Urceolaria scruposa (*Ach.*) On rocks. Glendalough. T. J.

No. 80.—Urceolaria scruposa (*Ach.*), *var.* bryophila. Sheepwalk, Armagh. T. J.

USNEA (*Dill.*).

No. 238.—Usnea barbata (*Fries*), *var.* florida. Castle Barnard. T. J.

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* *See* Mudd's "Manual," p. 287.

† *See* "Lichen. Scand.," p. 155.

VERRUCARIA (*Wigg.*).

No. 118.—Verrucaria biformis (*Borr.*) Demesne, Armagh. T. J.
See also No. 162.

*No. 346.—Verrucaria (Sphæromphale) Carrollii (*Mudd*). Demesne, Armagh. Not on old ash trees. T. J.

I have given my only Irish specimen of this plant to the Herbarium. It has also been found by Mr. Carroll in the Co. Cork.* As it is minute, and only exhibits the superior of the apothecium, it is easily passed over; but as I subsequently found it on old paling in England (*see* my No. 1505), it probably is not so rare.

No. 51.—Verrucaria chlorotica (*Ach.*). Rocks, south of the coast guard station, Woburn, Co. Down. T. J.

It appears that Mudd† considers this plant not altogether the same as *V. chlorotica* (Ach.); nay, he refers it to another genus, *Arthopyrenia*, on account of its septate spores. He, however, retains the plant of *Acharius*.‡

No. 100.—Both forms. On birch bark. Demesne, Armagh. T. J.

Mr. Carroll thinks this *V. carpina*. No. 525 (*Schær.*). Exteriorly it neither corresponds with Schœrer's specimen, No. 525, nor with Hepp's, No. 459, which he names *V. fusiformis*, and same as *V. carpinea*. Interiorly the plant corresponds with *V. chlorotica*, having paraphyses and acute 3-septate spores.

No. 85.—Verrucaria chlorotica, *var.* fusiformis (*Leight.*). Barclay's Rock, Co. Down. T. J.

This is the same as No. 51, but noticed here to prevent any mistake, there being another plant in the same specimen. *See* No. 86.

No. 310.—Verrucaria cinerea (*Pers.*). Near Cork. T. J.

*No. 330.—Verrucaria cinerella (*Flot.*). Glengariff, on holly. T. J.
Named by Nylander.

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* *See* Mudd's "Manual," p. 283. † Ibid., p. 300. ‡ Ibid., p. 285.

*No. 312.—Verrucaria consequens (*Nyl.*) Glenarm, on chalk rocks, covered at high water. T. J.

This and No. 311 grow together. This plant is generally destitute of thallus, but gonidia are always present. From the arrangement of *apothecia* and similarity of spores, it may be considered, perhaps, a rock form of *V. epidermidis.*

No. 336.—Glenarm, on chalk rocks, covered at high water. T. J.

As this was the first plant named by Nylander, it ought to be considered the type. I cannot say I observed any passage of it into the form seen in No. 312; but internally the two plants correspond; the spores 8 in asci, ·0006″ by ·0003″. Nylander says of this plant:—"Affinis est V. scopulariæ, *Lich. Scand.*, p. 282, est quasi *Verrucaria epidermidis-saxicola.*"

No. 188.—Verrucaria Dufourii. Ballymore, Co. Carlow. T. J.

Contains also *L. stellulata* and *L. parasema.*

No. 94.—Verrucaria epidermidis (*Ach.*). Demesne, Armagh. T. J.

Mr. Carroll notices the minute *Verrucaria* to which the *finger* points; he thinks it *V. punctiformis* (*Leighton*), so minute as to justify the name *atomaria*, but not Mr. Mudd's plant.*

No. 101.—Birch bark. Demesne, Armagh. T. J.

Both forms of fructification.

No. 135.—Desmesne, Armagh. T. J.

*No. 328.—Verrucaria epidermidis tremella (*Ach.*) Old Dromore. T. J.

Named by Nylander.

*No. 329.—Verrucaria epidermidis, *var.* punctiformis (*Ach.*). Glengariff, on holly. T. J.

Named by Nylander.

No. 121.—Verrucaria epipolœa (*Ach.*), conoidea (*Fr.*). Sheepwalk, Armagh. T. J.

No. 133.—Verrucaria gemmata (*Ach.*). Demesne, Armagh. T. J.

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* Ibid., p. 289.

*No. 93.—Verrucaria glaucina (*Ach.*). Sheepwalk, Armagh. T. J.

Dr. Nylander has not noticed this form in his "Expos. Synop. Pyren." Mr. Mudd considers it as a variety of *F. fuscella.** The form, however, is constant, and is found in Devonshire and Kent.

No. 272.—Verrucaria lavata (*Ach.*)—Near Cork. T. J.

*No. 313.—Verrucaria lectissima (*Nyl.*), *var.* leptalia (*D.R.*), Curraghmore, on Portugal-laurel. T. J.

No. 5.—Verrucaria maura (*Wahlb.*).—Barclay's Rock, Co. Down. T. J.

*No. 311.—Verrucaria micropororoides (*Nyl.*) Glenarm, on chalk rocks, covered at high water. T. J.

See my No. 1587.

By thallus this plant is distinct from *V. maura* and *V. mucosa.* As small portions of No. 312 are seen on this specimen, the difference also between Nos. 311 and 312 are exhibited. The thallus of this plant is cartilaginous; the apothecia prominent, almost papillate; paraphyses none; spores 8 in each ascus, ·0003″ by ·0002″. Iodine has little effect, causing only a slight yellow.

*No. 52.—Verrucaria microspora (*Nyl.*), var. South of coastguard station, Co. Down. T. J.

Nylander has seen this plant, and pronounces it as here named.†

*No. 11.—Verrucaria mucosa (*Wahlb.*). Rocks seldom uncovered, except at spring tides, Co. Down. T. J.

This plant has been overlooked; it is, however, very abundant, and, owing to thallus, very conspicuous. Named by Dr. Nylander. The specimen shows both forms of fructification.

No. 9.—Verrucaria nigrescens (*Pers.*). Lime-capped wall, Woburn, Co. Down. T. J.

*No. 63.—Verrucaria pyrenophora (*Ach.*). Sheepwalk, Armagh. T. J.

No. 17.—Verrucaria (?) rupestris (*Schrad.*). Barclay's Rock, Co. Down. T. J.

No. 167.—Verrucaria rupestris (*Schrad.*). Sheepwalk, Armagh. T. J.

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* *See* Mudd's "Manual," p. 305, Ex. in No. 298.

† *See* Nylander's "Expositio Synoptica Pyrenocarpeorum," pag. 29.

*No. 331.—Verrucaria subumbrina (*Nyl.*). Glencree. W. A.

This plant has been found in Ireland only by Mr. Archer. As it has a cartilaginous smooth thallus, so far not corresponding with my Scotch plants, I thought it right to ask Dr. Nylander's opinion; he has named it as above. This plant has eight eventually dark spores in each ascus, and in size very similar to the spores of *Verrucaria umbrina*, which has only two spores in each ascus. I am sorry I have mislaid specimens of the true *V. umbrina* found in the Dargle.

*No. 257.—Verrucaria Taylori (*Carroll*). Near Cork. T. J.

No. 106.—Verrucaria ——— ? Barclay's Rock, Co. Down. T. J.

Mr. Carroll does not offer an opinion on this *Verrucaria*. It belongs to Nylander's division, *Paraphyses none;* has large spores, ·0009″ by ·0003″, round at the ends, broader at one end, obscurely 1-septate, the septum not always central, sometimes at one-third, and perhaps the normal condition is 3-septate.

No. 154. Verrucaria —— ? Demesne. Armagh. T. J.

This is not *Verrucaria chlorotica* (Nyl.), as the spores are entire; it may be Mudd's *chlorotica.**

No. 190.—Verrucaria and Lecidea. Same as No. 185. Ballymoon, Co. Carlow. T. J.

No. 192.—Verrucaria, principally V. rupestris (*Schrad.*). Ballymoon, Co. Carlow. T. J.

No. 291.—Verrucaria (nearest V. Dufourii) (*DC.*), and Lecidea lenticularis. Sheepwalk, Armagh. T. J.

No. 334.—Verrucaria Dufourii (*DC.*). Rocks outside Muckross demesne. T. J.

See No. 1563.

If seen when the weather is moist, the thallus of this plant resembles *V. chlorotica;* it has entire spores, and on examination I think it near *V. Dufourii.*

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* *See* Mudd's "Manual," pag. 285.

No. 339.—Verrucaria ——— ? Castle Barnard demesne wall. T. J. *See* 1862.
This resembles *V. rupestris;* it has more prominent apothecia and larger spores; they measure ·0015 by ·006; they are entire.

I append for the use of those consulting the specimens the following List of the Lichens in the Collection, in the order in which they occur therein; the species not recorded in Mackay's "Flora Hibernica" being marked with an asterisk:—

List of the Lichens to be found in the Four Fasciculi.

No.
1. Lecanora atra (*Ach.*)
2. Urceolaria calcarea (*Ach.*), form.
3. Lecidea aromatica (*Turn.*)
4. Lecidea aurantiaca (*Leight.*), form.
5. Verrucaria maura (*Wahlb.*)
6. Ramalina scopulorum (*Ach.*), both forms.
7. Lichina confinis (*Ag.*), both forms.
8. Lichina pygmæa (*Ag.*), both forms.
9. Verrucaria nigrescens (*Pers.*)
10. Lecidea coniops (*Wahlb.*)
*11. Verrucaria mucosa (*Wahlb.*)
12. Opegrapha Chevalieri (*Leight.*)
13. Lecidea ferruginea (*Huds.*)
14. [*Wanting*].
15. Lecanora glaucoma (*Hoffm.*)
16. Physcia obscura (*Hoffm.*), *var.* adglutinata (*Nyl.*)
17. Verrucaria? rupestris (*Schrad.*)
18. Lecanora subfusca, (*Ach.*) *var.*
19. Lecidea stellulata (*Tayl.*)
20. Lecidea rupestris (*Ach.*)
21: Lecidea contigua (*Fr.*)
22. Peltigera polydactyla (*Hoffm.*)
23. Parmelia saxatilis (*Ach.*)
24. Parmelia omphalodes (*Ach.*)

No.
25. Parmelia caperata (*Ach.*)
26. Sphærophoron coralloides (*Pers.*)
*27. Scoliciosporum (Lecidea) vermiferum (*Nyl.*)
28. Lecanora cervina (*Schrad.*, *Pers.*), form.
*29. Lecidea lenticularis (*Ach.*)
30. Ramalina scopulorum (*Ach.*)
31. Bæomyces rufus (*Whalb.*)
32. Lecidea myriocarpa (*DC.*), and L. vermifera (*Nyl.*)
33. Parmelia (Physcia) aquila (*Ach.*), both forms.
34. Scoliciosporum (Lecidea) vermiferum (*Nyl.*) (A confused mixture of Lichens).
35. Cladonia coccifera (*Ach.*)
36. Parmelia perlata (*Ach.*), *var.* ciliata (*DC.*)
37. Lecanora parella (*Ach.*)
38. Collema cheileum (*Ach.*)
39. Parmelia olivacea (*Ach.*), *var.*
40. Cladonia furcata (*Fries.*), *var.* pungens (*Ach.*)
41. Lecanora subfusca (*Ach.*), *var.*
*42. Thelidium (Verrucaria) aggregatum (*Mudd.*)
43. Placodium ———?
44. Lecidea ferruginea (*Huds.*)
45. Lecanora sophodes (*Ach.*)

No.
46. Placodium murorum (*Hepp*).
47. Lecidea stellulata (*Tayl.*)
48. Lecanora cinerea (*Nyl.*)
49. Lecidea sulphurea (*Ach.*)
50. Squamaria saxicola (*Ach.*)
51. Verrucaria chlorotica (*Ach.*)
*52. Verrucaria microspora (*Nyl.*), *var.*
53. Leptogium lacerum (*Swartz*).
54. Physcia parietina (*Nyl.*)
55. Spærophoron compressum (*Ach.*)
56. Leptogium Burgessii (*Lightf.*)
57. Cladonia endiviæfolia (*Fries*).
58. Sticta pulmonaria (*Hook.*), both forms.
59. Thelotrema lepadinum (*Ach.*)
60. Thallus, unknown. I think Amphiloma, which never fruits with us. From Killarney. Collected by Dr. Moore.
61. Pannaria rubiginosa (*Thunb.*)
62. Collema ——— ?
*63. Verrucaria pyrenophora (*Ach.*)
64. ? Leptogium, (L. Moorii, *Hepp*).
65. Endocarpon miniatum (*Ach.*)
66. Endocarpon miniatum, *var.* complicatum (*Ach.*)
67. Endocarpon fluviatile (*Ach.*, *DC.*)
68. Umbilicaria pustulata (*Ach.*)
*69. Phlyctis agelæa (*Ach.*)
70. Lecanora albella (*Ach.*)
71. Lecidea disciformis (*Fr.*)
*72. Physcia candelaria (*Nyl.*)
73. Lecidea uliginosa (*Schrad.*)
74. Lecanora coarctata (*Ach.*)
75. Lecanora coarctata? perhaps L. ornata (*Smfl.*)
*76. Abrothallus Smithii (*Tulasne*).
77. Lecidea vernalis (*Ach.*)
78. Pertusaria (Stigmatidium) crassa (*Dub.*)

No.
79. Urceolaria scruposa (*Ach.*)
80. Urceolaria scruposa, *var.* bryophila (*Ach.*)
81. Stereocaulon denudatum (*Flk.*)
82. Lecanora subfusca (*Ach.*), and parasitic Verrucaria.
83. Graphis Smithii, *var.* divaricans (*Leight.*)
84. Lecidea Templetoni (*Tayl.*)
85. Verrucaria chlorotica, *var.* fusiformis (*Leight.*)
86. Lecidea petræa (*Flot.*)
*87. Lecidea atro-grisea (*Delise.*)
88. Parmelia conspersa (*Ach.*), *var.*
89. Opegrapha varia (*Pers.*)
*90. Physcia chrysophthalma (*Schær.*)
*91. Physcia flavicans (*Nyl.*)
92. Lecidea vernalis (*Ach.*)
*93. Verrucaria glaucina (*Ach.*)
94. Verrucaria epidermidis (*Ach.*)
95. Lecanora sophodes (*Ach.*)
96. Lecanora sophodes (*Ach.*), *var.* roboris (*Duf.*)
97. Graphis elegans (*Ach.*)
98. Urceolaria Acharii (*Hook.*), and a Verrucaria.
99. Opegrapha varia, (*Pers.*), form.
100. Verrucaria chlorotica (*Ach.*), *var.*
101. Verrucaria epidermidis (*Ach.*), both forms.
*102. Lecidea Pineti (*Ach.*)
103. Lecidea luteola, *var.* rubella (*Ach.*)
*104. Lecidea disciformis (*Fr.*)
105. Lecidea albo-atra (*Hoffm.*)
106. Verrucaria ——— ?
107. Lecanora ventosa (*Ach.*)
*108. Sphinctrina anglica, perhaps Sph. turbinata (*De Not.*)
109. Lecidea ferruginea (*Huds.*)
110. Lecanora cerina (*Ach.*)
111. Lecidea premnea (*Fries*).

No.
112. Opegrapha epiphega (*Ach.*)
113. Gyalecta exanthematica (*Sm.*)
114. Lecidea atro-grisea (*Delise*), form.
115. Opegrapha varia (*Pers.*), form.
116. Lecanora parella (*Ach.*)
117. Lecidea atro-grisea (*Delise*).
118. Verrucaria biformis (*Borr.*)
119. Physcia pulverulenta (*Schreb, Fr.*, *Nyl.*)
120. Lecidea ——— ? (not ferruginea); fruit not perfected.
121. Verrucaria epipolœa (*Ach.*), conoidea (*Fr.*)
122. Ramalina calicaris (*Ach.*), fraxinea (*Linn.*)
123. Parmelia perlata (*Ach.*)
124. Parmelia Borreri (*Turn.*)
125. Collema pulposum (*Ach.*)
126. Placodium murorum, *var.* citrinum (*Ach.*)
127. Lecanora aurantiaca, *var.* erythrella (*Ach.*)
128. Lecidea aromatica (*Turn.*)
129. Opegrapha vulgata (*Ach.*)
130. Placodium murorum (*DC.*) citrinum.
131. Cladonia squamosa (*Hoffm.*)
132. Graphis inusta (*Ach.*), Gr. Smithii, *var.* divaricata (*Leight.*)
133. Verrucaria gemmata (*Ach.*)
134. Collema. Mr. Carroll thinks C. cristatum (*Leight.*), form.
135. Verrucaria epidermidis (*Ach.*)
136. Leptogium tenuissimum (*Kbr.*)?
137. Cladonia? pyxidata (*Fr.*)
138. Physcia obscura, *var.*
139. Lecanora (Urceolaria) calcarea (*Ach.*)
140. Arthonia cinnabarina (*T.* and *B.*)

No.
141. Graphis scripta (*Ach.*, *Nyl.*), G. serpentina (*Leight.*)
142. Leptogium lacerum (*Swartz*)
143. Collema? furvum (*Ach.*)
144. Opegrapha atra (*Pers.*) State.
145. Collema ——— ?
146. Collema melænum (*Ach.*) Mr. Carroll thinks *cristatum* (Leight.)
*147. Leptogium Schraderi (*Bernh.*), fruited.
148. Physcia parietina? Form.
149. Lecidea lenticularis (*Ach.*)
150. Parmelia olivacea (*Ach.*), rough form, not fruited.
151. Parmelia? saxatilis (*Ach.*)
152. Pannaria nigra (*Huds.*)
153. Leptogium? scotinum (*Ach.*)
154. Verrucaria ——— ? (not *chlorotica*).
*155. Lecidea Lightfootii (*Ach.*)
156. Parmelia (state of *P. obscura*).
157. Lecanora albella, form (*Ach.*)
158. Physcia parietina (*Nyl.*), form.
159. Opegrapha atra (*Pers.*)
160. Lecanora aurantiaca, form.
161. Pertusaria pustulata (*Leight.*)
162. Lecidea parasema and Verrucaria biformis, mixed.
163. Stigmatidium crassum (*Dub.*)
164. Lecanora subfusca and a parasitic fungus.
165. Pannaria microphylla (*Sw.*, *Massal.*); sterile. Mr. Carroll doubts.
166. Opegrapha rupestris (*Pers.*)
167. Verrucaria rupestris (*Schrad.*)
*168. Lecidea calcivora (*Nyl.*), *var.* immersa (*Sm.*)
169. Lecidea myriocarpa (*DC.*)
170. Pertusaria. Mr. Carroll thinks *P. pustulata.*

No.
171. Opegrapha atra (*Pers.*)
172. Opegrapha varia, form; and Lecanora varia.
*173. Myriospora Heppii (*Näg.*)
*174. Lecidea bacilifera (*Nyl.*)
*175. Lecidea lutiella (*Nyl.*)
*176. Lecidea sphæroides (*Smmrf.*)
177. Lecidea lenticularis (*Ach.*), chalybeia (*Borr.*)
178. Bæomyces rufus (*DC.*)
179. Lecidea (Scoliciosporum) vermiferum (*Nyl.*)
*180. Lecanora badia (*Ach.*)
181. Lecanora cervina (*Schrad.*, *Pers.*)
182. Lecidea contigua (*Fr.*)
183. Lecanora (Urceolaria) calcarea, *var.* contorta (*Flk.*)
184. Leptogium muscicolum, form?
*185. Lecidea atrosanguinea (*Hoffm.*)
186. Lecidea rivulosa (*Ach.*)
187. Lecidea calcarea (*Weiss.*)
188. Lecidea stellulata (*Tayl.*), also Verrucaria Dufourii.
189. Lecidea parasema (?) saxicola.
190. Verrucaria and Lecidea, as No. 185.
191. Lecidea (supposed L. contigua).
192. Verrucaria, form, principally V. rupestris.
193. Arthonia cinnabarina (*T.* & *B.*)
194. Fungoid (?). From Borris, Co. Carlow.
195. Lecidea parasema (*Ach.*)
196. Parmelia physodes (*Linn.*, *Ach.*)
197. Sticta scrobiculata (*Ach.*)
198. Sphinctrina anglica (*Linn.*)
199. Cladonia coccifera (*Ach.*)
200. Cladonia coccifera, *var.* macilenta (*Hoffm.*)
201. Graphis dendritica (*Ach.*)

No.
202. Evernia prunastri (*Ach.*)
203. Sticta fuliginosa (*Ach.*)
204. Stigmatidium crassum (*Dub.*)
205. Pertusaria globulifera (*Hook.*)
206. Pertusaria syncarpa (*Mudd*).
207. Pertusaria ——— ?
208. Pertusaria communis (*DC.*)
209. Pertusaria communis (*DC.*)
210. Pertusaria globulifera (*Hook.*)
211. Pertusaria communis (*DC.*)
212. Pertusaria communis (*DC.*), form.
213. Pertusaria fallax; form, P. Wulfenii (*Ach.*), fide Nylander.
214. Pertusaria fallax, form.
215. Pertusaria, (form known as *Variolaria faginea*).
216. Pertusaria leioplaca (*Schær.*)
217. Pertusaria pustulata (*Leight.*)
*218. Lecanora Turneri (*Sm.*)
*219. Graphis Lyellii (*Sm.*)
220. Physcia cæsia (*Nyl.*)
221. Parmelia pulverulenta (*Ach.*)
222. Physcia stellaris (*Nyl.*)
223. Physcia obscura, form.
224. Lecidea (?), and Phlyctis agilæa (*Ach.*)
225. Cladonia endiviæfolia (*Fries*).
226. Cladonia furcata (*Fr.*), *var.* pungens (*Ach.*)
227. Parmelia conspersa (*Ach.*)
228. Parmelia lævigata (*Ach.*)
229. Ricasolia herbacea (*Ach.*)
230. Parmelia perlata *var.* ciliata (*DC.*)
231. Pannaria plumbea (*Delise.*)
232. Lecanora hæmatomma (*Ach.*)
233. Lecanora albella (*Ach.*)
234. Lecanora varia (Mr. Carroll thinks L. orosthea, *Ach.*)

No.
*235. Opegrapha involuta (*Wallr.*)
236. Sticta limbata (*Ach.*)
*237. Sticta intricata (*Del.*), *var.* Thouarsii (*Nyl.*)
238. Usnea barbata, *var.* florida (*Hoffm.*)
239. Ramalina calicaris, *var.* farinacea (*Fr.*)
240. Sticta sylvatica (*Ach.*)
241. Peltigera polydactyla (*Hoffm.*)
242. Nephroma lævigatum (*Ach.*)
*243. Leptogium tremelloides (*Ach.*)
*244. Collema multipartitum (*Sm.*)
245. Gyalecta truncigena (*Ach.*)
*246. Squamaria gelida (*Linn.*)
*247. Lecidea sublurida (*Nyl.*)
*248. Lecidea inspersa (*Tulasne*).
*249. Lecidea mutabilis, (*Fée*), both forms.
250. Lecidea premnea (*Fries*).
251. Urceolaria Acharii (*Hook.*)
*252. Lecidea lutea (*Dicks.*)
253. Stigmatidium Hutchinsiæ (*Nyl.*)
254. Verrucaria.
255. Pertusaria rupestris (*DC.*)
256. Lecanora subfusca (*Ach.*), form.
*257. Verrucaria Taylori (*Carroll*).
*258. Melanotheca gelatinosa (*Chev.*)
259. Arthonia epipasta (*Ach.*)
260. Stereocaulon paschale (*Ach.*)
261. Arthonia ilicina (*Tayl.*)
262. Cladonia macilenta (*Hoffm.*)
263. Cladonia uncialis (*Hoffm.*)
264. Lecidea quernea (*Ach.*)
265. Lecidea abietina (*Nyl.*)
*266. Calicium tympanellum (*Ach.*)
267. Lecidea quernea (*Ach.*)
268. Lecidea premnea (*Fries*).

No.
*269. Lecidea grossa (*Pers.*)
270. Collema ? flaccidum (*Ach.*)
271. Urceolaria calcarea, *var.* contorta (*Flk.*), form.
272. Verrucaria lavata (*Ach.*)
*273. Graphis anguina (*Mont.*)
274. Lecanora subfusca (*Ach.*), *var.* pannaroides (*Carroll*).
275. Opegrapha varia (*Pers.*), form.
276. Lecidea (Placodium) canescens (*Ach.*)
277. Opegrapha vulgata (*Ach.*)
*278. Graphis elegans (*Ach.*), and Lecidea disciformis (*Fr.*)
279. Collema ———?
280. Lecanora hæmatomma (*Ach.*)
281. Lecidea sublurida (*Nyl.*)
282. Opegrapha atra, *var.* parallela (*Leight.*)
283. Arthonia astroidea (*Ach.*)
284. Lecanora atra (*Ach.*) (?), with both forms of fructification.
285. Lecidea quadricolor (*Dicks.*), decolorans (*Flk.*)
286. Lecidea disciformis (*Fr.*), both forms of fruit.
*287. Lecanora erysibe (*Ach.*)
288. Lecidea (?) aurantiaca (*Leight.*)
289. Lecanora coarctata (*Ach.*)
290. Lecanora subfusca (*Ach.*), *var.*
291. Verrucaria ———? (nearest Dufourii) Lecidea lenticalaris.
292. Lecanora subfusca (*Ach.*), form as to thallus. Also a Verrucaria, Mr. Carroll thinks a form *saxicola* of *V. rhyponta* (*Ach.*)
293. Mixture of lichens, Lecidea disciformis.
294. Mixture of lichens, Lecidea myriocarpa.

No.

295. Lecanora tartarea (*Linn.*)
296. Lecanora aurantiaca, form.
297. Lecanora sulphurea (*Hoffm. Massal.*)
298. Lecidea petræa (*Flot.*)
*299. Physcia leucomela (*Schær.*)
*300. Pannaria muscorum (*Delise*), *var.* determinata (*Nyl.*)
301. Sticta Damæcornis (*Ach.*), *var.* macrophylla. (*Hook.*)
302. Cladonia papillaria (*Hoffm.*)
303. Lecanora atrocinerea (*Dicks.*)
304. Sphærophoron coralloides, (*Pers.*)
305. Lecanora tartarea (*Linn.*)
306. Alectoria jubata (*Linn.*)
307. Cetraria glauca (*Ach.*)
*308. Gyrophora polyphylla (*Linn.*)
*309. Nephroma lævigatum (*Ach.*), form.
310. Verrucaria cinerea (*Pers.*)
*311. Verrucaria microporoides (*Nyl.*)
*312. Verrucaria consequens (*Nyl.*)
*313. Verrucaria lectissima (*Nyl.*) V. leptalia (*D. R.*).
314. Lecidea(?) Lightfootii (*Ach.*) form.
*315. Lecanora albariella (*Nyl.*)
*316. Lecanora varia, *var.* intricata (*Ach.*)
317. Physcia ——— ? also P. parietina.
318. Placodium murorum, form.
*319. Lecidea fusco-rubens (*Nyl.*)
320. Physcia lychnea (*Ach.*)
321. Lecanora (very near No. 316).

No.

*322. Parmelia Mongeotii (*Shær.*)
*323. Pannaria triptophylla (*Ach.*)
324. Pannaria ——— ?
325. Sticta fuliginosa (*Ach.*)
326. Physcia ——— ?
327. Physcia tenella (*Ach.*); form.
*328. Verrucaria epidermidis, *var.* tremella (*Ach.*) Named by Nylander.
*329. Verrucaria epidermidis, *var.* punctiformis (*Ach*). Named by Nylander.
*330. Verrucaria cinerella (*Flot.*) Named by Nylander.
*331. Verrucaria subumbrina (*Nyl.*)
332. Leptogium (?) palmatum (*Ach.*)
333. Lecanora sophodes, *var.* roboris (*Duf.*)
334. Verrucaria Dufourii (*DC.*) ?
*335. Pertusaria nolens (*Nyl.*)
336. Verrucaria consequens (*Nyl.*)
*337. Thelidum (Verrucaria) Auruntii (*Masal.*)
338. Opegrapha varia (*Pers.*), *var.* diaphora (*Ach*)
339. Verrucaria ——— ?
340. Opegrapha Persoonii (*Ach.*)
341. Opegrapha rupestris (*Pers.*)
*342. Opegrapha herpetica (*Ach.*)
343. Ephebe pubescens (*Fr.*)
344. Placodium murorum, form.
345. ,, ,,
*346. Verrucaria (Sphœromphale) Carrollii (*Mudd*).
*347. Pannaria cheilea (*Nyl.*)
348. Lecidea incana (*T. et B.*), pachycarpa (*Duf.*)
349. Gyrophora erosa (*Web.*)

The following five Species are pronounced by Dr. Nylander to be *new;* he has accordingly named them, and has informed me that he intends describing them in the "Flora" :—

No.
175. Lecidea lutiella (*Nyl. in litt.*)
311. Verrucaria microporoides (*Nyl. in litt.*)
312. Verrucaria consequens (*Nyl. in litt.*)

No.
315. Lecanora albariella (*Nyl. in litt.*)
335. Pertusaria nolens (*Nyl. in litt.*)

XVI.—On Flax, and the Practicability of Extending its Cultivation in Ireland; together with Directions for the Proper Management of that Crop.

By Edmund W. Davy, M. B., M. R. I. A., &c., Professor of Agriculture and Agricultural Chemistry to the Royal Dublin Society.

[Read before the Royal Dublin Society, February 15, 1864.]

Notwithstanding that the extension of the cultivation of Flax in this country has from time to time been strongly advocated, it is much to be regretted that till recently its culture has been almost entirely confined to the North of Ireland, where, as is well known, that plant has been successfully cultivated for a long period.

Several circumstances, however, occurring recently—such as the failure in the supply of cotton, owing to the protracted war in America; the low prices and unremunerative returns from our cereal and other usual farm crops, consequent in a great measure on a succession of bad seasons; and the great emigration which has recently taken place from our shores—have united in a remarkable manner to force on us the importance of extending the growth of a crop like Flax, which is a plant that is not injured to the same extent by excessive rains, and different atmospheric influences as our cereal and other ordinary crops; gives much agricultural and industrial employment; and, above all, the cultivation of which, and the subsequent manufacture of its fibre, have conduced so much to the prosperity of the North of Ireland, and of those districts in other countries where it has been extensively grown and manufactured. Consequently, were this plant in more extensive cultivation in all parts of our island, we might reasonably hope in some degree to arrest the tide of emigration now taking place from this country, by being able to give our poorer fellow-countrymen more constant employment, and offer them a more adequate remuneration for their labour than they now obtain in so many instances,—thus enabling them to support their families in some degree of comfort at home. So general is this feeling just now, and so much has the attention of the public been of late engaged with this subject, that we can scarcely take up a number of any of our agricultural, or even daily papers, for some months back, without meeting either an article on this subject, or an account of a meeting held somewhere, for the purpose of promoting the growth of Flax in Ireland.

As this subject appears to be now engaging so much public attention, the present Paper, containing the history of Flax from the earliest times down to the present day, and the most important points to be known as to the character and proper cultivation of that plant, and its subsequent treatment for the production of fibre, as well as different facts which show the practicability and advantages of extending the growth of Flax in this country, will not, I trust, be unacceptable to those intending themselves to introduce that plant amongst their other agricultural crops, or who wish to encourage others in doing so; in addition to which, considerable interest is attached to the Flax plant, whether we regard the antiquity and extent of its cultivation, or the many important purposes to which mankind have applied its fibre, from a very remote period, as well as the number of useful applications made of different portions and products of this plant in more recent times.

THE EARLY HISTORY OF FLAX.

In point of antiquity, there are few plants, and those only used for food, that can take precedence of Flax; for we find frequent allusion made to it both in its growing and manufactured state as linen, in the early Books of the Old Testament, which are, as is well known, amongst the most ancient records in existence.

It seems probable that Egypt was the native country of the Flax plant, or at least that there its cultivation first attained a degree of perfection for which it has been celebrated from the remotest periods down even to the present time; and the extent to which it was cultivated in that country from the earliest periods may be inferred from the Book of Exodus, where the mention made of it would appear to show that it was then one of the most important crops of the Egyptians; and, consequently, when the Almighty inflicted the plagues on the land of Egypt, this crop was one of those injured or destroyed by the hail; for we read in the ninth chapter and thirty-first verse, that "the Flax and barley were smitten,"—showing, by its being mentioned along with that important cereal, the value which was attached at that time to the Flax crop by the Egyptians.

It would appear also, from the First Book of Kings, tenth chapter and twenty-eighth verse, where we are told that Solomon brought out of Egypt *linen yarn*, that they had considerable traffic with the people of other countries in that article.

From Herodotus also, the oldest of profane historians, we learn that Egypt was the great emporium or market for the Flax trade; and the high estimation in which the Flax plant was held by the people of Egypt may also be inferred from the fact that we find the plant itself, or the preparation of its fibre, represented on many of their monuments; and in their mummies the microscope has shown that the clothes in which they rolled or enveloped their embalmed dead some 1200 years before the Christian era were made of the fibre of the Flax plant.

The Greeks appear to have been well acquainted with Flax and the preparation of its fibre; for we find *linen* mentioned by Homer and other early Greek writers. And as to the Romans, we have abundant evidence in the works of their different historians, and writers on rural economy, that this plant was extensively cultivated by that people.

Though Flax and its cultivation are referred to by the several Roman writers on agriculture, Pliny seems to be the only one of them that enters minutely into detail as to the growth and subsequent treatment of that crop, which appear to have been conducted pretty much in the same manner as at the present time. Amongst other interesting observations which he makes in reference to this plant, he states that the Flax of Cumæ, in Campania (which was much esteemed on account of the fineness and toughness of its fibre for the manufacture of nets used in fishing and fowling), was employed in the making of toils or hunting nets for catching wild boars, and that* he has seen some of these nets of such a degree of fineness as to allow of their being passed, together with their ropes, through the ring of a man's finger,—a single individual being able to carry as many of such nets as would surround the hunting ground; this, he further observes, is not so very surprising as that each of the cords of such nets should be composed of 150 threads.

Such network appears to have been used in the manufacture of armour long before that time by the Egyptians; for Herodotus speaks of a curiously made *linen corslet,* preserved in the Temple of Minerva at Lindus, in the Isle of Rhodes, which originally belonged to Amassis, one of the kings of Egypt, 600 years B.C. Curious enough, in Pliny's time, a portion of this same corslet, which was made of a sort of network, each thread or strand of which consisted of the enormous number of 365 fine threads, was exhibited in Rome at the time he wrote, as a specimen of strength and fineness of fibre, as well as of skill in the preparation and spinning of thread.

Much as we may have improved in different mechanical appliances for the separation and manufacture of Flax fibre, there appears to be nothing in modern times that can be compared with the fineness, strength, and complexity of the thread used in the making of the nets and corslet just referred to.

During the dark or middle ages which succeeded the fall of the Roman Empire, the absence of all agricultural records leaves a blank in the history of Flax till about the end of the twelfth century, when we learn from different documents relating to that period, that Flax was grown to a considerable extent in England; being, as it is supposed, introduced into Britain some time after the Norman Conquest, as it is not enumerated amongst the titheable articles of that period; and it was not till the year 1175 that Flax and hemp were included, by the Council of Westminster, amongst those productions from which the clergy were to receive their dues.

As the country became less disturbed by civil wars, more attention was devoted to agriculture and the useful arts; and with the consequent advance of civilization, the manufacture and employment of linen became more general. The importance which was subsequently attached to the growth of Flax in England is shown by the different Acts of Parliament which were passed enforcing its cultivation: thus, in 1532, during the reign of Henry VIII., an Act was passed obliging each person occupying land fit for tillage to sow at least one rood of Flax for every sixty acres of such land in his possession. This quantity was subsequently increased to one acre in 1562, during the reign of Elizabeth, and the provisions of the Act enforced under a severe penalty.

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* Plin. Nat. Hist., lib. xix., cap. 1.

With a view of encouraging the growth of Flax in England as much as possible, we find that in the year 1691, during the reign of William and Mary, an Act was passed, fixing the tithe on Flax as low as four shillings per acre; and later, in the reign of Queen Anne (1713), a bounty of one penny per ell on home-made sailcloth was given, as an encouragement to that manufacture.

THE INTRODUCTION AND CULTIVATION OF FLAX IN IRELAND.

We now pass to our own country, with which we are more particularly interested, and proceed to very briefly trace the history of the Flax plant from the earliest records we have of its being cultivated there down to the present time.

At what period Flax was first grown in Ireland there is no means of determining; it appears, however, that it must have been known in that country from a very remote period; for in an ancient Irish manuscript, written 200 years before the Christian era, the shield of a great warrior mentioned in it is described as being made of alternate layers of linen and leather; and in the thirteenth century we read of the Irish chieftains and their soldiers wearing saffron-coloured garments, which are supposed to have been made of linen; and it is therefore probable that Flax was cultivated, and linen manufactured from it to some extent in Ireland, from the earliest times.

But, though the growth of Flax gradually extended in this country, as well as in England, from the great encouragements given to it by the State, it did not acquire any degree of national importance till the close of the seventeenth century, when the linen trade received a great impulse by the revocation of the Edict of Nantes, by which act, in 1685, Louis XIV. drove out of France more than 50,000 of the most industrious and intelligent of his subjects, many of whom, well skilled in the manufacture of linen, settled in this country, as well as in England, where they introduced many improvements in that branch of industry from France and the Low Countries, where at this time the making of linen had been brought to considerable perfection.

This was more especially the case with M. Louis Crommelin, who after the repeal of that edict fled from France (in 1699), accompanied by a number of refugees, who, coming to this country, settled in the neighbourhood of Lisburn, near Belfast; and being acquainted with the best methods then known in France of growing and manufacturing Flax, imparted that knowledge to the people of the district in which they came to reside, and this information was afterwards extended to other parts of the country; and to that circumstance we may fairly attribute the reason why Flax has been grown to a greater extent and with more success in the province of Ulster than in any other part of Ireland.

Shortly after the period just referred to, the Irish Parliament confirmed the establishment of the linen trade in Ulster; and a board of trustees was appointed in 1711 to encourage and extend this rising manufacture; and with a view to increase the demand for, and consumption of, linen, the Duke of Ormonde, whilst holding here the office of Lord Lieutenant, directed that linen scarfs and hatbands should be worn at funerals—a custom, as is well known, still prevailing.

Soon after this period, the manufacture of linen seems to have steadily progressed, and different improvements were made by the application of new mechanical contrivances, as well as by the use of various chemical agents in the preparation and bleaching of the fibre and the manufactured linen. Thus, Dr. James Fergusson, of Belfast, was awarded in 1764 a sum of £300 by the Linen Board, for the successful application of lime in the bleaching of linen, as a substitute for the excreta of animals, which, as an alkaline reagent, was commonly employed in that process; and the same gentleman subsequently, in 1770, introduced the use of sulphuric acid instead of buttermilk, which was previously in general use, as an acid, in the bleaching process.

Various other improvements were rapidly introduced after this time, amongst which were the employment of potash in the alkaline ley used for boiling the yarns and cloth; and the still greater improvement in the application of chloride of lime as a bleaching agent, which has done so much in facilitating the bleaching of linen, as well as of many other useful substances.

It would be tedious to trace still further the advancement of this manufacture in Ireland, and to show how, step by step, this country became celebrated for its linens: suffice it to say, that the Linen Hall in Dublin soon became the great depôt to which linens were sent by the different manufacturers of this country, and that there merchants and traders from various parts repaired for the purchase of such manufactures.

The means of transport, however, becoming more easy by the construction of new roads throughout the country, and still more so by the application of steam to locomotive and marine travelling, the manufacturers in the North of Ireland soon found it more to their advantage to send their goods direct from Belfast across the Channel to Liverpool, Manchester, or London, where they had agents to dispose of them, than to send them up to Dublin; and thus the Linen Hall, which was in former days a place of much commercial importance, has sunk into its present deserted condition; and a considerable portion of it has been converted into a barrack, or devoted to other purposes very foreign to those for which it was originally intended.

In 1828, the Government, considering that the linen trade in Ireland was sufficiently established to be independent of public support, dissolved, by the consent of Parliament, the Linen Board; and all further grants for the promotion of the linen manufacture were suspended. After this for a time the cultivation of Flax in Ireland seems to have declined, no doubt from the want of some society like the Linen Board to watch over and encourage the linen manufacture. In 1841, however, the Belfast Flax Improvement Society was formed, which gave new impulse to the cultivation and manufacture of Flax, and originated many improvements. Amongst other means that were taken for the carrying out of the objects of their Society, they brought over from Belgium persons skilled in the culture of Flax, to instruct our people; and finding afterwards that this was not sufficient for the purpose intended, they selected a number of intelligent young men, who were sent to Belgium to be instructed in the Flemish mode of cultivating and preparing Flax; and the result of this excellent proceeding was soon apparent in the increased quantity and improved quality of the Flax produced in the North of Ireland. The Royal Dublin Society, too, which has always been ready to encourage any project having for its object the promotion of the agricultural and industrial prosperity of this country, by its offering prizes at its triennial and other exhibitions, for the best Irish linens, has aided in no small degree to advance this important manufacture.

The formation of the Belfast Flax Improvement Society was soon followed by others, which gave increased stimulus to Flax culture, especially the North-Eastern Agricultural Association for Promoting the Growth of Irish Flax, which took the place of the former society, and is now actively promoting the objects of that association.

But, though the growing of Flax and the manufacture of linen have (owing to the encouragement of those Societies and other circumstances) been flourishing in the North of Ireland, the culture of that plant in other parts of this country has been hitherto either very limited or entirely neglected; and little or no attempt, except in a few instances, has been made to introduce Flax as a regular crop amongst our agricultural rotations. Such a desirable end, it is scarcely necessary to say, is the object of the present great Flax movement, which, if carried out, as there is no doubt it will be, is calculated to effect much good for our people and country.

THE BOTANICAL RELATIONS AND THE GENERAL CHARACTERS OF THE FLAX PLANT.

The common Flax plant (the *Linum usitatissimum*) is a delicate-looking plant, which usually attains a height of about two feet, but may, under very favourable circumstances, grow much higher. It has a slender rounded stem, which is but slightly branched, and is thinly covered with narrow glaucous three-ribbed leaves, and bears at its summit a few elegant pale-blue shining flowers.

The fruit is a globular cartilaginous capsule, splitting when fully ripe into ten boot-shaped valves, each containing a single seed; these seeds which are brown, shining and oval, constitute the well-known linseed.

This plant, which is the most characteristic and important species of the genus *Linum*, belongs to the Natural Order of *Lineæ*, or *Linaceæ* (the Flaxworts) which are remarkable for the tenacity of their fibre, the mucilaginous character of their seed, and, as a general rule, the beauty of their flowers. This Family, according to Dr. Lindley, contains three genera, and about ninety species, which are irregularly distributed over the greater part of our globe.

The principal stations of this Order of plants are—Europe, North Africa, and North and South America; though individual species are to be met with in India, New Zealand, Australia, and other countries. As to the Flax plant itself, it is remarkable for the great range of climate in which it may be grown. Thus, in Europe, we find it cultivated in Norway, Sweden, and Russia, as far north as 64° and 65° north latitude, and from this extending to the shores of the Mediterranean. It is grown also in North Africa, the temperate parts of Asia, on the east side of North America, and in other districts, in more or less quantity. But the chief Flax-growing districts are the three following, viz.:—First, those portions of Russia and Prussia lying south-east of the Baltic, from which there is an exceedingly large exportation by Riga, Revel, Libau, Pernau, and St. Petersburgh, to a great portion of Northern Europe, as well as to England and this country, both as Flax and Flaxseed. The second district is that of Belgium, Holland, and part of France, from which, especially from Belgium, we get the finer kinds of Flax fibre,—the coarser being principally obtained from Russia. The third, is that of Egypt, which chiefly supplies the countries bordering on the Mediterranean.

The great capability of the Flax plant to grow in such very opposite climates as to temperature may be partly accounted for, when we recollect that it is an annual of very rapid growth, which soon completes the period of its existence; so that it can be cultivated in the summer in the colder climates, and in the winter in the hotter: thus, for example, in Egypt it is sown in December or January in the fields just quitted by the Nile, and is harvested in April or May; whilst with us, and in colder climates, it is sown in April or May, and gathered in August or September; and by this arrangement the differences of temperature during the period of its growth are not so very great, comparatively speaking, between the northern parts of Europe where flax is grown and that of Egypt.

This power which the Flax plant possesses of adapting itself to a wide range of climate is of great importance, as it enables mankind to cultivate such a valuable plant in so many countries, and under such diverse circumstances, which, were it not for this adaptability of the Flax plant, would be impossible.

THE SOILS ADAPTED FOR THE GROWTH OF FLAX, AND THE CONDITIONS FOR ITS SUCCESSFUL CULTIVATION.

As in the case of climate, so in that of soil, we find that the Flax plant is capable of growing under very diverse conditions; for we find it cultivated in soils partaking more or less of the sandy, argillaceous, calcareous, or peaty character according as sand, clay, lime, or vegetable matter—the four great constituents of soils in general—preponderate. And it appears that the success of the Flax crop does not so much depend on the particular kind of soil in which it is grown, as on the condition to which that soil has been brought, and the skill and attention bestowed on the culture and management of the crop. However, as in the case of other plants, there are certain soils which appear to be more especially adapted for the growth of this plant; and it is a point of some practical importance to know the description of soil best adapted for the Flax crop, where the agriculturist may have different kinds of soil at his disposal for its culture.

General experience seems to show that Flax succeeds best on a deep loamy soil, or one in which there is an intimate admixture of those four soil constituents just mentioned, in such proportion as to partake to some extent of the properties of each. Further, it should at the same time be neither too wet nor too dry, and of such an open and friable character as will readily permit the delicate fibrous roots of the Flax plant, which frequently grow to a length of two or three feet, to extend themselves freely in a vertical and lateral direction in search of food. For this reason, strong stiff clays should be avoided, as they do not permit this ready extension of the roots. On the other hand, very dry gravelly soils are found to be unsuitable for the growth of this crop. However, as a general rule, Flax may be grown on any soil of even moderate fertility; but of course it will grow in the greatest luxuriance, and yield the largest produce, where the land is most fertile and of that open and friable character which seems to be best adapted to its nature.

The conditions for its successful cultivation, are—that the soil be deeply tilled, well cleaned and drained, and be at the same time in good heart and tilth. The importance of each of those conditions, as regards the growth of Flax, is easily understood: thus, depth of tillage, whether effected by the plough or spade in preparing the soil for Flax, as for other crops, has the effect of increasing the feeding ground, as it were, from which the plant receives its earthy food, and places at its disposal a larger amount of those mineral substances which are indispensable to the growth of this as of other crops; and thus materially aids and favours the growth and development of the plant.

As to cleaning and freeing the soil as much as possible from weeds in the cultivation of Flax, its importance is obvious to any one who reflects, that where the same soil is producing two crops—the one yielding the agriculturist either money or meat, and the other neither, whilst at the same time it is consuming rapidly the available mineral food for the remunerative crop, and thus impoverishing his land—the sooner and more completely such crops are got rid of, the better.

This is more particularly the case in the growth of Flax, which, being in its cultivated condition of a delicate and slender habit, is ill fitted "to rough it,"—as it has been happily expressed—with the stouter and stronger indigenous weeds.

As to draining, the many beneficial effects produced in the soil by that process, consequent on the removal of excessive moisture, and the admission of air, which are so well known and seen in the growth of our other crops, are especially required by Flax; and it is idle to expect that it will grow with profit where there is an over-abundance of moisture in the soil. Therefore, one of the most important points to be attended to in the growth of this plant is, that the ground be thoroughly drained.

The last two conditions referred to are—that the soil should be in good heart and tilth, or, in other words, that it should contain the necessary substances, and that its particles should be in a highly comminuted state. As to the first, its importance is obvious, for from no other source than the soil can this, like our other crops, derive those earthy constituents which are necessary for their growth and development. As to the second, that the ground should be in good tilth, this condition, which practice has long shown to be of great importance in the growth of all our crops—has only been recently fully appreciated by the vegetable physiologist and chemist; as it has been shown that the mineral food of plants cannot be conveyed to their roots from a distance by water percolating through the soil, because the latter, having a great attraction for those substances, readily removes them from water holding such bodies in solution, and retains them firmly locked up, as it were, in some physical state of combination, and consequently the rootlets must receive the principal supplies of their earthy constituents from those portions of the soil in immediate contact with them; and from such the substances required become gradually dissolved, either by some solvent action of the roots, by the agency of carbonic acid, or by other circumstances not clearly made out, whereby the roots can gradually imbibe their mineral food, when and in such quantities as they require. Hence we see the necessity of having the soil in good tilth; for the finer the state of division to which we reduce its particles, the greater will be the surface of soil we enable the delicate rootlets of plants to come in contact with; and by thus increasing the surface of absorption, we enable them to acquire more readily, and in greater proportion, their necessary mineral constituents. This comminution of the particles of the soil is of especial importance in the cultivation of Flax, which, being a rapid growing plant (the whole period of its growth occupying only from about fourteen to sixteen weeks), and its rootlets being of a fine fibrous character, it requires to be rapidly supplied with nutriment, which condition will be fulfilled by having the soil where it is grown in good heart and tilth, and of a sufficiently open and friable condition to allow the rootlets freely to extend themselves in search of food.

THE ROTATION IN THE CASE OF FLAX, AND THE PREPARATION OF THE SOIL FOR THAT CROP.

As to the crop which Flax should follow or precede in rotation, the peculiar characters of this plant enable it to occupy almost any place in the rotation which the nature of the soil, the climate, the market, or the circumstances of the grower, may render most advantageous: thus, it may follow or precede a grain or a green crop, a forage plant or a following; such positions it is found occupying in different countries where it is extensively and successfully cultivated.*

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* The North-East Agricultural Association of Ireland, in their directions for the proper management of the Flax crop, recommend the following rotations:—

As a general rule, however, the best rotation on soils of average quality is after wheat or other grain crops, for the following reasons—that, after the reaping of those crops, the autumn affords an opportunity for having the land thoroughly cleaned and deeply ploughed, and for leaving it in such a state exposed to the air during the winter, that its decomposing and disintegrating action may produce a fine tilth. The stubble, too, of those crops acts beneficially in keeping the land open, and thus facilitating the action of frosts and rains in this disintegrating process, and thus materially aids in producing a fine condition of the surface soil, suitable to receive the seed in the following spring.

Mr. Wilson, in his valuable little work, "Our Farm Crops," observes, in speaking of the cultivation of Flax, "that if the land intended for that crop has been thoroughly tilled and cleaned in the autumn, and left with a good deep winter furrow, it will require but little preparation in the spring: at that period of the year," he says, "*it is always better to avoid using the plough, if possible,* because the finely weathered surface is by it turned in; and it is well nigh impossible by any mechanical treatment of the soil, to reduce a fresh furrow slice to the same tilth; while every time any implement or animal passes over the surface, it becomes compressed and consolidated, and in some soils and seasons materially injured."

Though what Mr. Wilson states as to the desirability of not using the plough in spring appears in theory to be correct, there is much diversity of opinion and practice on this point; for many recommend and adopt spring ploughing. If, however, it is thought desirable to plough in spring, it should not be deeper than about three or four inches, so as to preserve the winter surface for the growth of the plant, and it is always better that it should be performed some time before the sowing of the seed, which will allow the seeds of different weeds remaining in the ground to vegetate, and by so doing, many of them will be killed or removed in the subsequent harrowings of the soil to prepare it for receiving and covering in the seed, and thus avoid a good deal of trouble in the weeding of the crop afterwards.

As to the application of manure to the ground intended for Flax, its direct employment in this country is not generally practised, fearing lest the rankness of growth resulting from it would render the Flax more liable to lodgment, and consequent injury during summer rains; besides, it is thought that the ground is sufficiently enriched by the manure employed in the growing of the preceding crops. If, however, the land is considered too poor, it may receive a light application of any of our

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RICH SOILS.	AVERAGE SOILS.	POOR SOILS.
1. Grass.	1. Grass.	1. Grass.
2. Oats.	2. Oats.	2. Oats.
3. Flax.	3. Potatoes or turnips.	3. Potatoes.
4. Potatoes or turnips.	4. Wheat.	4. Flax (on half only).*
5. Wheat.	5. Flax (on half only).†	5. Hay.
6. Clover hay.	6. Clover hay.	
7. Pasture.		

* Omit Flax in next rotation on this half.

ordinary manures, or artificial Flax composts, which may be applied before the last harrowing of the ground to prepare it for the seed.

I shall defer all further details as to the preparation of the ground, the sowing of the seed, and the subsequent treatment of the crop, till the latter part of this paper, in which, under the Directions for the Proper Management of the Flax Crop, these and other practical matters connected with the culture of Flax, will be fully treated.

CHEMISTRY OF THE FLAX PLANT.

I shall now offer a few remarks on the chemistry of the Flax plant, which will enable us to judge whether one of the great arguments against the extension of the growth of Flax, viz., that it is a very exhausting crop, is a fair one. Flax, like other plants, consists of two parts, viz., the organic and inorganic—the combustible and incombustible, or mineral portion. The former, which constitutes the chief part of the plant, consists, as is well known, of four simple bodies, viz., carbon, hydrogen, oxygen, and nitrogen, the first three or all of which, grouping themselves together in certain proportions, form the cellulose of which the fibre consists, the oil, and other organic substances produced during the growth of this plant. The latter,—the inorganic or mineral part, which constitutes the ash that is left when the plant is burnt,—consists of some nine or ten different substances, and amounts to from three to four and a half per cent. of the seed, and about five per cent. of the straw of the Flax plant; and though the quantities of each of those mineral matters are small when compared with the organic part, still they are all indispensably necessary to the growth of this, as of our other crops.

In the nutrition and growth of Flax, as of other plants, the organic elements—the carbon, hydrogen, oxygen, and nitrogen—are supplied directly or indirectly, under different compound forms, from the atmosphere, in unlimited quantities. The inorganic or mineral substances, however, not occurring in the air, can be only derived from the soil. Now, though all of those nine or ten mineral substances are equally important as regards the growing plant, they are not practically of equal value to the agriculturist, for this reason, that some of them occur in almost inexhaustible quantities in most soils, and therefore require little or no attention on his part, whereas others, occurring more sparingly in soils, may be either originally deficient, or by the continued growing of different crops which remove more or less of them be soon reduced to such a small proportion, that the soil cannot yield the necessary quantity, and consequently different crops (especially those that require a good supply of the deficient substances) cannot be grown, at least with any profit, on such impoverished or exhausted soils. Therefore, it is those sparingly distributed mineral matters that require the especial attention of the agriculturist. Now, general experience seems to show that the two most important of the mineral constituents of plants, as regards the agriculturist, are—*phosphoric acid and potash;* not only because they are generally sparingly distributed in the soil (at least, in an available condition), but likewise as being the most costly to purchase of the mineral constituents of our manures.

All our agricultural crops are more or less exhaustive; that is, they all remove from the soil those mineral substances required by plants. But some of them, requiring a larger amount of those sparingly diffused substances (particularly the two bodies just referred to), may, in one sense, be considered more exhaustive than others for the generality of soils.

We shall now consider what are the total quantities of mineral matter, of phosphoric acid, and of potash, which from the results of chemical analysis have been estimated to be removed from the soil by average crops of some of our most important plants, including Flax; those quantities are shown in the following Table:—

Total Quantities of Mineral Matter, of Phosphoric Acid, and of Potash, removed from a Statute Acre by an Average Crop of the following Plants:—

		Entire Mineral Matter.		Phosphoric Acid.		Potash.	
			Total Quantity.		Total Quantity.		Total Quantity.
Wheat, .	in the Grain, . .	25 lbs.	178 lbs.	11·47 lbs.	19·65 lbs.	7·49 lbs.	25·70 lbs.
	„ Straw, . .	153 „		8·15 „		18·21 „	
Oats, . .	„ Grain, . .	58 „	228 „	10·55 „	14·90 „	9·72 „	42·26 „
	„ Straw, . .	170 „		4·35 „		32·54 „	
Barley, .	„ Grain, . .	49 „	208 „	17·25 „	22·43 „	9·68 „	38·93 „
	„ Straw, . .	159 „		5·18 „		29·25 „	
Beans, . .	„ Grain, . .	63 „	231 „	23·67 „	35·83 „	22·63 „	111·80 „
	„ Straw, . .	168 „		12·16 „		89·17 „	
Peas, . .	„ Grain, . .	96 „	432 „	32·18 „	48·41 „	35·85 „	51·74 „
	„ Straw, . .	336 „		16·23 „		15·89 „	
Potatoes, .	„ Tubers, . .	400 „	580 „	50·28 „	63·99 „	223·00 „	273·43 „
	„ Tops, . . .	180 „		13·71 „		50·43 „	
Turnips, .	„ Bulbs, . .	340 „	640 „	33·11 „	60·99 „	125·73 „	201·68 „
	„ Tops, . . .	300 „		27·87 „		75·95 „	
Beet, . .	„ Bulbs, . .	483 „	1539 „	19·80 „	78·00 „	149·70 „	385·50 „
	„ Tops, . . .	1056 „		58·20 „		235·80 „	
Flax, . .	„ Bolls, . . .	48 „	272 „	18·00 „	33·50 „	11·00 „	25·00 „
	„ Straw, . .	224 „		15·50 „		14·00 „	

The above quantities in the case of all the crops, with the exception of Flax, are from the results of analyses by different chemists, given in Morton's "Cyclopedia of Agriculture," where the quantities taken as average crops are estimated at the following amounts:—

Wheat, ...	Grain, . .	25 Bushels, at 60 lbs. each.
	Straw, . .	at twice the weight of the Grain.
Oats, ...	Grain, . .	50 Bushels, at 40 lbs. each.
	Straw, . .	at two-thirds more than the Grain.
Barley, ...	Grain, . .	40 Bushels, at 52 lbs. each.
	Straw, . .	at one-fourth more than the Grain.
Beans, ...	Grain, . .	25 Bushels, at 63 lbs. each.
	Straw, . .	at 2800 lbs.
Peas, ...	Grain, . .	50 Bushels, at 64 lbs. each.
	Straw, . .	at 5600 lbs.
Potatoes, . . .	Tubers, . .	at 8 Tons.
	Tops, . .	at 4½ „
Turnips, ...	Bulbs, . .	at 20 „
	Tops, . .	at 6 „
Beet, ...	Bulbs, . .	at 30 „
	Tops, . .	at 5 „

The quantities in the case of Flax are from the results of Dr. Hodges, who estimates two tons of straw, and sixty bushels of bolls, dried, and weighing 960 lbs., as an average crop of Flax.

From the above Table it would appear, taking one thing with another, that there is no great difference between the exhaustive power of Flax and our ordinary cereals—that in some respects it is less so than beans or peas; but that it is far less exhaustive than either potatoes, turnips, or beet, whether we consider the total quantity of mineral matter, the phosphoric acid, or the potash removed from the soil; so that we cannot regard Flax as a particularly exhausting crop, as is generally done.

But here we view it under the most unfavourable aspect; for it rarely happens that the whole of the crop is sold off the farm, but the seeds, or a portion of them, are used for feeding purposes, and the straw is very commonly steeped there, and it is only the Flax fibre that is disposed of.

If, however, the water which is used in steeping the Flax was employed for irrigation, and the expressed seeds or linseed cake, for feeding the cattle on the farm, we would return to the soil almost all the mineral matters taken up by the plant; for the Flax fibre and oil—the two most important products of this plant—retain, after proper preparation, but a very small proportion of mineral matters—those of the straw remaining to a great extent in the water used for steeping, and those of the seed in the expressed cake.

These statements are borne out by the analyses of Sir Robert Kane, the late Professor Johnston, Messrs. Way and Ogston, Dr. Hodges, and other chemists, who have investigated this subject, and have all maintained the non-exhausting characters of Flax if properly cultivated.

From the elaborate and important investigations of Messrs. Way and Ogston on the mineral constituents of plants, these gentlemen have been led to conclude that an average crop of Flax contains a larger amount of mineral matter than an average crop of any of our cereals produced from the same extent of ground; but that only a small portion of that matter belongs to the fibre, the part of the plant which is permanently removed from the soil, and that this consists almost entirely of comparatively valueless substances. The really valuable soil constituents, they find, are contained chiefly in the leaves, which in a great part drop off on the field, in the seed and seed vessels (which should be returned to the soil in the form of manure); and, lastly, in the organs of the stalks, irrespective of the fibre. They have further ascertained, that about four-fifths of the soil constituents contained in the stalk, and those the most valuable (phosphoric acid, potash, &c.), are extracted by the water during the operation of steeping; and that nearly three-fourths of the remaining portion are again separated with the woody parts by the scutching, &c., leaving only a minute quantity (comparatively speaking) of mineral matter in the fibre.

Consequently, the results of those gentlemen confirm, in a most satisfactory manner, the statements of other chemists as to the Flax plant, the cultivation of which by no means produces a necessary exhaustion of the soil, which almost ceases when the refuse matters obtained in the separation of the fibre, especially the water used in steeping the Flax, are returned to the soil.

From Dr. Hodges' experiments, he calculates, that if the fibre were only sold off the farm, a crop of two tons of straw per acre would remove only about five pounds of mineral matter—a quantity too small to exercise any appreciable injurious effect on the fertility of the soil.

Flax, therefore, instead of being (as is very unjustly regarded) one of the most exhaustive crops, would, if so cultivated, be one of the least in this respect that we could possibly grow. Nay, more, it would certainly have the effect of increasing the fertility of the soil; because the tillage and the workings of the ground—which are so necessary for the successful cultivation of Flax—must tend greatly to improve the physical and chemical condition of the soil, rendering it far more suitable for the growth of other crops.

In proof of this, I may remark, that the Flemish agriculturists, who may be justly considered as the most successful Flax growers in Europe, and best agriculturists generally, regard Flax, not as a crop that exhausts, but as one that improves the condition and fertility of the soil.

But, supposing that no part of the plant is returned to the soil, all being sold off the farm, and even granting that this crop removes a larger amount of those sparingly-diffused mineral substances (which we have shown is not the case), still, the Flax plant being such a rapid grower, and consequently occupying the ground for so short a period, and yielding when properly cared a greater money return than any of our other crops, its cultivation would be highly profitable, and leave the grower after purchasing, if he could not produce, the manure necessary to maintain the fertility of his ground, a larger profit, generally speaking, than he could possibly obtain by the exclusive culture of the less remunerative cereal and green crops.

THE PRACTICABILITY AND ADVANTAGES OF EXTENDING THE GROWTH OF FLAX IN IRELAND.

So much has been said and written of late on the practicability and advantages of extending the cultivation of flax in this country, that it is scarcely necessary for me, in a Paper like this, to dwell on that part of the subject, or to urge the desirability of those who have influence and wish for their country's prosperity uniting their efforts in furtherance of this national object, which promises, if carried out properly, to improve the condition of all classes throughout Ireland, and will, it is hoped, by giving increased employment, stem to some extent the great current of emigration taking place from our shores.

I may, however, observe, that the practicability of growing Flax in other parts of Ireland besides the North may be inferred from what I have already stated, as to the great power the Flax plant possesses of adapting itself to such a wide range of soil and climate; furthermore, practical experience has shown that Flax may be successfully grown in almost every part of Ireland. And the desirableness of extending its cultivation may be inferred from seeing the very prosperous condition of those parts of this country where Flax is extensively grown, as in the province of Ulster; which, were it not for the cultivation of the Flax plant, and the manufacture of linen from its fibre, would now be some of the most impoverished and backward parts of this country. And so fully alive are the people of the North of Ireland to the growing importance of this branch of agricultural and commercial industry, that they have greatly extended the cultivation of this plant; whilst in other districts of Ireland their example has been recently followed to some extent; so that there was a greater amount of Flax produced last year in Ireland than was ever previously grown in this country, and greatly in excess over the former year; thus, the number of English acres under Flax in 1862 was 150,070 acres; and in 1863, 214,099 acres—being an increase of 64,029 acres, or considerably more than one-third greater than in the preceding year; and the Flax crop on the whole appears to have been in every way most profitable; and in many instances large sums were realized by different individuals from the sale of their Flax crop; and though there was a much larger supply, the price of Flax still kept up, from the great demand for that substance.

In the present year, the amount of Flax sown throughout Ireland, as far as can be learned, greatly exceeded that sown last year;* and the prospects of the crop appear to be very good.

Again, there is no reason why other parts of Ireland should not as well as the North participate in the advantages derivable from the growth of Flax; for it is generally believed that the soil and climate of many other districts are far more favourable to the growth of this crop than the colder and more mountainous districts of the North; and there are many instances of Flax being grown in the South, and in other parts of this country, with the greatest success and profit to the grower.

ADVANTAGES OF THE FLAX CROP.

Amongst the advantages of the Flax crop may be mentioned the following:—

First,—It is not so liable to be injured by wet seasons as our cereals and other crops. This is shown by the experience of the last few years, which have, as is well known, been very injurious to our grain crops, but have not affected (at least to the same extent) that of Flax.

Second,—Its growth is very rapid, so that it occupies the ground a short time, comparatively speaking, and thus enables us to grow a greater number of crops on the same soil.

Third,—It is far more profitable, when properly attended to, than any of our other crops. It is difficult, however, to state what is the average yield and profit on an acre of Flax, as they vary so much according to a great variety of circumstances.

Fourth,—Its culture supplies not merely a source of agricultural, but of industrial employment; in this respect it is more beneficial than any of our grain or other crops occupying the same extent of ground, in addition to its being more valuable.

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* From the recent returns of the Registrar-General for the present year, published September, 1864, we learn that the acreage amount of Flax sown this year exceeds that of last year by 87,761 acres.

Fifth,—It may at all times be included in the ordinary rotation of crops without fear of exhausting the soil, if we do not grow it too frequently on the same ground, or take care to return to the soil, either in the Flax water and linseed cake (the latter having served first as food for the cattle on the farm), or in some other manure, the mineral substances removed by the crop. If Flax be cultivated with these precautions, the fertility of the ground will remain unimpaired for any number of years.

That these and many other advantages derivable from the growth of Flax are now so generally admitted, and that its more extended cultivation in Ireland is considered both practical and tending to improve the condition of this country, is evidenced by the active measures which are now taking place throughout Ireland to carry out this important object. Thus, we hear of meetings being held of the different agricultural societies, and of the chief persons of various towns and districts, to encourage the extension of the growth of Flax in this country. Nay, more, companies have been formed in different places, and other active steps taken to give immediate effect to the advancement of this great national object,* which, if attained, there can be no doubt would materially improve the agricultural, social, and commercial condition of Ireland.

DIRECTIONS FOR THE PROPER MANAGEMENT OF THE FLAX CROP.†

THE SEED, AND THE SOWING OF IT.

It is a matter of much importance to the grower of Flax to select proper seed, as a good deal of the success or otherwise of the crop will depend on the kind which is sown. Foreign seed is universally preferred; and for the generality of soils that obtained from Russia, and known under the name of Riga seed, is the best, although Dutch seed in many districts has been used for a series of years with perfect success, especially in the case of heavy damp soils, and is said to yield a Flax of finer fibre, though not so large a crop as that grown from Riga seed. If neither can be procured, home-grown seed may be used, it being preferable to American, which from its producing plants having a tendency to branch, instead of growing with single erect stems, causes much of the fibre to be lost in the scutching. In purchasing seed, that which is shining, plump, heavy, and feels slippery to the hand, should be selected, as indicating that such seed is fresh, a circumstance of much importance, as seed beyond a year old should not be sown. In all cases, however, it will be safest to buy the seed from the most respectable establishments, even though by so doing the cost of the seed may be somewhat greater.

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* In furtherance of that important object, since this Paper was read, the Government have granted a sum of £2000, which has been placed at the disposal of a joint committee of the Royal Dublin Society and of the Royal Agricultural Society, for the encouragement and promotion of Flax culture in this country.

† Though the Directions here given for the proper management of the Flax crop were not read before the meeting of the Royal Dublin Society, it was thought that this paper, when published, would be rendered much more practically useful by having them added to it.

Before sowing, the seed should be sifted, to separate from it the seeds of all weeds it may contain, which will save a great deal of trouble in the weeding of the crop afterwards. This may be effected by using wire sieves having twelve bars to the inch, which, being constructed for this purpose, can easily be procured.

As to the proportion of seed that ought to be sown, it may be stated at from two to three bushels to the statute acre; the former quantity for poor, and the latter for rich soils; about 2½ bushels, or 126 lbs. of clean seed being taken as a fair average quantity.

It should, however, be remembered that it is always better to sow rather too thick than too thin, when the principal object in growing Flax is the fibre; for, when thickly sown, the stems grow tall and straight, and but slightly branched at the top, producing a fibre far superior in length and fineness to that of Flax grown thin, which on the other hand is much branched, and produces a good deal of seed, but the fibre of which is coarse, and of very inferior quality.

The ground having been well pulverized and cleaned by previous ploughing and harrowing, a light roller should be passed over it, to give an even surface, and produce a certain amount of consolidation; after which a short toothed or seed harrow follows; and if the ground has not been laid down in ridges, it should be marked off in divisions of from eight to ten feet in width, for the better distribution of seed at the time of sowing. On the ground so prepared, the seed is sown broad cast, by hand or machine, in the proportion stated; and after the sowing of the seed, which should be done by a very skilful person, it is covered by passing a seed harrow once up and down the divisions, and once across or anglewise, which has the effect of distributing the seed more evenly, and avoids the small drills made by the teeth of the harrow. This being done, a light roller should be passed over the ground, unless it is so wet as to adhere to it in clods, when of course that operation should be dispensed with, being then far more injurious than beneficial. In the sowing of Flax it ought also to be borne in mind that the seed should be covered only by about one inch of earth, which is the proper depth at which it ought to be placed in the ground.

As to the time of sowing, the end of March or the beginning of April is the period that is generally recommended, and it is of great importance that it should be done in dry weather. But the time of sowing will to some extent be influenced by the special object in view in the cultivation of Flax: thus, when it is grown for fibre alone, or for the fibre and seed together, it is better to sow somewhat earlier than when the production of seed is the principal object; for, when sown late, the crop grows so quickly during the early summer months, that the vegetative processes are too rapid to give sufficient time for the consolidation of the tissues, which is necessary for the production of good fibre, and which the slower vegetation of the spring months generally secures where the sowing has been performed early; consequently, for fibre purposes, about the last week in March, if the season is mild and favourable, is the best time; when both fibre and seed are required, the sowing may be a week or two later; and when the production of seed is the principal object, it may be delayed till about the end of April.

THE WEEDING OF THE CROP.

If proper care has been bestowed on the cleaning of the seed and the ground, but few weeds will make their appearance; these, however, must be removed by careful hand-weeding. This is best effected when the Flax has attained a height of about three or four inches; but should be done before it exceeds six inches; for, if left longer, the Flax will be injured during the weeding. This process is generally performed by young persons, or females, who with coarse cloths round their knees, or having them well padded, weed in a kneeling posture, and creep along the ground on all fours. By this method the young Flax plants are less injured than by walking over the ground, especially if the weeders have shoes furnished with nails. For this operation a dry, windy day is most favourable; and the weeders should always work facing the wind, so that it may assist in raising the Flax plants which have been bent down in that direction during the weeding process. When the Flax, however, has been sown in ridges (as is sometimes done, especially where the ground is wet, or not properly drained), the weeders should work sideways from the pathways or furrows between the ridges, so as to injure the Flax as little as possible.

THE PROGRESS OF THE FLAX CROP, AND THE PROPER TIME FOR PULLING IT.

The plant having attained a height usually of about two feet (though sometimes growing much higher), flowers towards the latter end of June, or early in July, when its delicate blue blossoms present a very beautiful appearance. After the flowers fall off, the seed capsules or bolls begin to form, and acquire their full size about the middle or latter end of July. When fully formed, they are nearly globular, with the top surfaces slightly drawn up to a point; and on opening them are found to have usually ten cellular divisions, each containing a single seed, appearing at first as a colourless integument, enclosing a mucilaginous liquid, which soon assumes a more solid consistence, changing to a pale green, and afterwards, as the seed ripens, passing into a brown colour. As the plant becomes more matured, the stalks near the ground lose their green appearance, and assume a yellow tint, becoming at the same time considerably harder, from the contraction of the vessels through which the sap was conveyed; and this alteration will proceed gradually up the stem until it reaches the seed capsules, indicating the passage of the sap into those organs for the maturing of the seed; and soon after this, the plant, having completed the term of its existence, sheds its seed, and dies.

As to the proper time for pulling the plant, this depends on the principal object we have in view in cultivating Flax. Thus, if it be for the purpose of producing seed for either sowing or for the production of oil, the plant must remain until its seeds are ripe, which will be denoted by the hardened condition of the seed capsules, and the brown appearance of the seed, together with the yellow colour of the stems, and the falling off of the leaves. But if (as is generally the case, at least in this country) the object is the fibre, we must not allow the plant to be fully matured; for, if so, the fibre will be coarse, and of inferior quality. If, on the other hand, we pull it too early, although the fibre is fine, the great waste which is produced in the scutching and hackling renders it unprofitable. It is, therefore, a point of much practical importance to know the proper time at which Flax should be pulled.

General experience has shown that where Flax of good quality, but not of extreme fineness, is required, the best time for pulling is when the seeds begin to change from a green to a pale brown colour, and when about two-thirds of the stalk from the ground have become yellow. When, however, Flax of the very finest fibre is required, as in the manufacture of certain cambrics and muslins, it should be pulled before this, and is sometimes removed from the ground so early as when the Flax begins to flower. But the former practice is generally far the most profitable; for the higher price brought by the finer Flax does not compensate for the greater yield of fibre in the more matured plant, and for the seed, which may be very profitably used for feeding purposes, for the extraction of its oil, or even occasionally for sowing.

The Flax, as is well known, is pulled by simply catching it in small handfuls below the seed vessels, and laying each handful on the ground one across the other diagonally, taking care that the root ends of each bundle should be even like a brush, which will increase the value of the Flax to the spinner, and consequently to the grower, who will be fully repaid by the higher price received for any additional care and trouble bestowed in making up and placing the handfuls properly. After the pulling of the Flax, much diversity of practice exists as to its subsequent treatment previous to the steeping process, which, without going into some minor points of difference, may be divisible into the three following courses—viz., 1st. The Flax may be immediately freed from its seed capsules or bolls by rippling, and then steeped at once; 2ndly. It may be made into stooks or bundles of a peculiar construction, in which state it is suffered to dry gradually, and when this has been effected, the seed is removed by beating or rippling it, and the straw is shortly afterwards steeped; or, 3rdly. It may be dried, as before, and being stacked or otherwise stored up (the seed having been removed previous to the storing or subsequently, when convenient), the Flax straw is steeped the following summer. The first course, however, being the one which is generally practised (at least in this country), and is that which is most recommended to be adopted here, it will be well to describe it a little more in detail.

THE RIPPLING OF THE FLAX.

The Flax, having been pulled in the manner stated, is at once freed from its seed capsules; this, adopting the first course, is very easily effected by drawing it in small handfuls through a sort of comb termed a ripple, which is a simple instrument, consisting of a row of iron teeth* screwed into a block of wood. This, taken to the field where the Flax is being pulled, is fastened to the centre of a plank about nine feet long, supported on two stools. At the opposite ends of this the ripplers may either stand or sit astride, being at such a distance from the comb as to allow of their striking it properly and alternately.

The handfuls of Flax being placed diagonally across each other (as already stated, in the pulling), and bound up in bundles or sheaves, these are laid down at the right hand of the rippler, and untied, when he, taking up a handful and grasping it firmly with the one hand about six inches from the roots, and with the other having spread it out at the top so as to present a broad fan-like surface to the ripple, draws it quickly through the comb, and thus detaches the bolls. There is, however, some care and dexterity required in this process, so as not to injure the fibre, and the proper manner of performing it is best learned from those already acquainted with it. After the Flax is thus deprived of its bolls, the rippler lays it down on his left-hand side, placing one handful across the other, after which it is tied up into sheaves, and removed. The object of thus crossing the handfuls after rippling in tying up the sheaves is, that they may easily be separated from each other after the process of steeping, and spread out evenly in the subsequent grassing of the Flax. As to the bolls, they should be carefully collected by placing a winnowing sheet or cloth on the ground under the ripple to receive them as they fall off, the seed they contain being, as is well known, very valuable as a food for cattle, as well as for the manufacture of oil.

If the weather be dry, the bolls should be suffered to remain in the field, spread out on the winnowing cloths or other contrivance for drying, turning them from time to time to assist their drying; they may then be passed through a coarse riddle, and afterwards through fanners, to separate straws and leaves. If, on the other hand, the weather be moist, the bolls must be dried within doors, by being spread on the floor of a barn or loft where they can be exposed to a current of air, and turned twice a day.

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* The teeth of the ripple should be made of rod iron, half inch square, placed in the block so as to be three-sixteenths of an inch apart at the bottom and half an inch at the top, the angles of the iron being turned so as to be opposite the ripplers. These teeth should begin to taper to a point three inches from the top, and be about eighteen inches in length, which will give sufficient spring, and save much breaking of the Flax during the rippling process. Such an instrument can be readily made by any handy blacksmith.

When they are nearly dry, they are removed to a corn kiln, where they are exposed to a temperature not exceeding a summer heat, being carefully turned as long as moisture remains. By this plan of slow drying, the seed absorbs all the juices which remain in the husk, and becomes quite ripe. If, on the other hand, it is at once taken from the field, and dried hurriedly on the kiln, the juices will be destroyed, and in the shrivelled and dried-up seed but little nutritious matter will remain.

The bolls being thus dried and cleaned, either within or without doors as the case may be, the seed may be threshed out, when the plumpest and heaviest portion should be reserved for crushing, or even sowing, and the lighter seed and chaff may be very profitably employed as a food for cattle.

Adopting this treatment of Flax, it ought not, if possible, to be allowed to remain on the field the second day, but should as soon as it is pulled be rippled, and then immediately put to steep, in order to prevent its hardening, which would retard the various fermentative changes which take place during the steeping of the Flax.

THE STRUCTURE OF THE STEM OF THE FLAX PLANT, AND DIFFERENT MODES OF TREATING THAT PORTION OF THE PLANT TO EFFECT THE SUBSEQUENT SEPARATION OF ITS FIBRE.

The ultimate object of the steeping, and of other processes to which the stem of the Flax plant is afterwards submitted, being, as is well known, the separation of the fibre, it will be well to consider its structure, in order to understand more clearly how the different processes adopted may aid more or less in effecting that object. If a portion of the stem of this plant be broken across, and then carefully examined, it will be found to consist chiefly of three distinct parts—viz., the centre hard cellular tissue, having all the appearance of wood, and usually called the shove, or boon; a tubular sheath, placed around this, composed of bundles of long and tough fibres, cohering to each other firmly; and exterior to this, a thin and delicate skin or bark,— the whole, but especially the fibres, being as it were cemented together by a nitrogenous compound. This substance it is necessary to separate, in order to detach the fibre, and obtain it in a state fit for manufacturing purposes; but so intimate is the nature of its union with the fibre, that mechanical means alone are quite insufficient for its complete separation. Various methods have been proposed and adopted, which effect more or less completely the removal of this cementing substance; these may be divided into two classes—viz., those which accomplish its removal by directly dissolving it, and those which produce the same effect by its gradual decomposition.

Amongst the first are the various alkaline and acid chemical solvents, as well as steam and water at a high temperature; these, especially the latter, though they promised to be very advantageous, have not in practice realized the expectations entertained regarding them, and have consequently been almost entirely discarded. As to the second class, wherein the cementing material is removed by effecting its gradual decomposition, this object is carried out differently in different countries;—thus in some parts of America it is effected by leaving the Flax spread out on the grass to the action of the atmosphere for several weeks, whereby the cementing substance is gradually decomposed, so that the fibre can then be separated by the different mechanical processes through which it afterwards passes. This, however, is a very tedious process, and one attended with many disadvantages. The same end is more quickly and much better attained by steeping the Flax in water, which is the process adopted in most countries. This is carried out by either placing the Flax in very slow running streams or rivers, as in Belgium and some other parts of the Continent, or by putting it in pools specially constructed for that purpose, as with us,* and also adopted in many other countries. We shall therefore confine our remarks on steeping to the latter method of conducting it.

THE STEEPING PROCESS.

This operation requires much care and attention, as the value of the fibre and the profit it yields depend more, perhaps, on the manner in which it is performed than on any other operation of the Flax grower; consequently, it will be well to consider it somewhat in detail.

First, then, as to the pond or pool in which the steeping is conducted.—This should be made, if possible, some time before it is required, and in choosing a site for its construction particular attention should be paid as to the supply of water suitable for the process. It is desirable also that the situation should be warm and well sheltered, though not too much shaded by trees or otherwise. If these two circumstances as to water and situation are favourable, others are comparatively of minor importance.

The kind of water which is best adapted for the steeping of Flax is river water, especially that which has flowed for some distance exposed to the action of the air, by which more or less of its earthy salts are separated, rendering it softer, and more suitable for this purpose. Water which has flowed over peat, or through peaty soils, is generally found to answer very well. But, on the other hand, waters which contain a large proportion of carbonate of lime, and other earthy salts (as is generally the case with spring waters), giving to them more or less of the well-known character of *hardness*, are unsuited for the steeping of Flax; and waters which have anything of a ferruginous character from the presence of salts of iron should be especially avoided, as they are quite unfit for that purpose. As to the pool itself, the best size to construct it is from twelve to eighteen feet broad, by from three and a half to four feet deep, the length being in proportion to the quantity of Flax to be steeped; but with the breadth and depth given, a pool of about thirty feet in length ought to be sufficient to steep the Flax of one acre. The kind of soil which forms the bottom of the steep pool is thought to influence to some extent the colour of the fibre, a clay bottom being said to give a yellowish-white tinge, an alluvial soil, a bluish shade, whilst a peaty one produces frequently a very pure white. It is advisable that a small drain, six or eight inches deeper than the bottom of the pool, should be cut at a distance of a few feet from it on every side, for the purpose of either preventing any water passing from the surrounding soil into the pool which might injure the Flax; or, on the other hand, to prevent the water from the pool passing into the surrounding soil.

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* A clause in the Fishery Laws of this country prohibits the steeping of Flax in rivers or streams, on account of its rendering the water poisonous to fish, and great numbers having been before that prohibition destroyed during the steeping season.

If the ground be of a very porous character, it may be necessary likewise, in making the steep pool, to guard more effectually against the escape of water from the pool itself; this will be best effected by cutting a deep and narrow trench parallel to the sides of the pool, at a distance of about three or four feet from its sides, and then filling it with clay, which should be rammed hard, so as to render it as impervious to water as possible.

If river water cannot be obtained or made available for the filling of the pool, and recourse is obliged to be had to spring water, it should be put in the pool some five or six weeks before the steeping of the Flax, in order that the exposure to the air, by the separation it effects of more or less of its calcareous salts, may render it as soft as possible.

It will be sufficient, however, in the case of river water, to place it in the pool a day or so previous to the steeping of the Flax.

The water being in a fit state, the Flax is put into the pool in regular rows, the sheaves or bundles resting on their butt ends, and standing nearly upright, so that when the pool is filled it presents the appearance of a dense crop, with the summit of the stems just appearing at the surface of the water; or, as is frequently adopted, the bundles are laid on the flat in regular rows, the ties of each succeeding row resting on the roots of that immediately below it.

The Flax is then covered with either sods of grass, the green side resting on the Flax, with wheaten straw kept down with stones, or with logs of wood; the object being to keep the Flax completely under water, yet at the same time not resting on the bottom of the pool.

Where the water is at once suitable for steeping, as where there is a reservoir or pond at command, many adopt the practice of packing the Flax in the pool and covering it over in the way described first, and then letting in the water, which has this advantage, that the Flax can be better and more evenly packed than where the pool is full of water at the time of putting in the Flax.

After the Flax has been in the water a few days it swells, and becomes lighter, by the gases evolved during its fermentation, and additional weight must be placed over it to keep it under the water, which should be afterwards removed as the fermentation lessens and the Flax again becomes denser. Sometimes, too, it may be advisable to let in or draw off some of the water, to keep the Flax always, during its steeping, about two inches below the surface of the water, and not let it either be exposed to the air or be sunk too deep in the pool or resting on its bottom.

As to the time required to steep the Flax properly, this will depend on the temperature and state of the weather, the kind of water, the description of Flax, and many other circumstances; but as a general rule it will be sufficiently steeped after from eight to fourteen days, the process being more quickly effected in warm than in cold weather.

It is, however, of great importance that every Flax grower should know when the Flax has been sufficiently steeped, as its quality is much deteriorated by being left either too short or too long a time in steeping; and when it has arrived at a certain stage of the process, a few hours more or less materially affect the quality of the fibre, and consequently the profits of the Flax grower.

About the seventh day the Flax should be examined, the usual test being to take a few stalks of average thickness, and, breaking their shove or woody centre in two places, about six or eight inches apart, in the middle of the stalk, catch the broken shove with the fingers, and see if it can be easily pulled out (drawing it downwards) without breaking or tearing the fibre, and without any of it adhering to the shove. If this is found to be the case, the Flax has been sufficiently steeped, and should be removed from the pool without further loss of time; but if not so, of course the steeping must be continued. After the fermentation has subsided, this trial should be made about every six hours, as the changes which take place then are sometimes very rapid; and if the Flax be allowed to remain longer in steeping than is necessary, the fibre becomes weak and cottony; if, on the other hand, it is removed too soon, or before the test just mentioned indicates that it is advisable to do so, much of the fibre is broken off during the scutching, and its quality in general is coarse and dry.

When the test shows that it has been steeped enough, it should be very carefully removed from the pool; for in no state does the flax suffer greater injury from careless handling than immediately after steeping: consequently it should never be roughly lifted out of the pool with forks or grapes, but should be handed out carefully by men standing in the pool to others on the banks, the business of the latter being to place the bundles on their root ends close together, or on their sides, on a slope, where they are left to drain for from twelve to twenty-four hours before spreading; but the heaps should not be too large, lest the Flax might be injured by heating in that very damp condition.

As to the water itself which has been employed in the steeping, it should (where it is possible) be used for manurial purposes, as it contains a considerable amount of the most valuable mineral constituents of plants, and is found to constitute an excellent liquid application, especially for meadows.

THE SPREADING OF THE FLAX AFTER STEEPING.

The Flax, having been sufficiently drained, is removed to where it can be spread out, exposed to the air and light, the object being to cleanse and improve the colour of the Flax, as well as to dry it. For this purpose a clean, short, and thick piece of pasture ground should be selected; and, having mowed down or removed any weeds that may rise above the surface of the sward, lay the Flax evenly on the grass, spreading it out thin and very equally, which will be easily effected if the directions given under the head of rippling have been attended to; for the handfuls will then readily come asunder without being entangled. While on the grass, some recommend that it should be turned two or three times (which is done with a long wooden pole), with a view to prevent more completely its being of different shades of colour, from unequal exposure to the light and air, which is frequently the case from inattention to this circumstance. If it is to be turned, and should there be a prospect of rain, that ought to be done before it comes on, that the Flax may by the rain be beaten down, and made to lie close upon the grass, thus preventing its being blown about and disordered.

THE LIFTING AND DRYING OF THE FLAX BEFORE STACKING.

When the Flax has lain on the grass about six or eight days, if the weather be showery, or ten or twelve if it be dry, it ought to be ready in lifting. A good test of its being sufficiently thus exposed, or as it is termed "grassed," is to rub a few of the stalks from top to bottom, and if the wood or shove breaks easily and separates from the fibre, leaving it sound, the Flax has lain long enough on the grass; this is also indicated when a large proportion of the stalks or stems are observed to form a sort of bow and string, caused by the fibre contracting and separating from the central woody portion. But the most certain and most satisfactory test is to try how a small portion of the Flax behaves when submitted to the hand break or to the Flax mill.

In lifting the Flax, care should be taken to keep the lengths straight and the ends even, as otherwise much loss will occur in the subsequent breaking and scutching. Let it then be set up to dry for a few hours, and afterwards be neatly tied up in small sheaves or bundles; and if it is not to be soon scutched, it should be stacked, or packed under cover; but in either case it ought to be put up loosely, that the air may get through it, and that there should be no danger of its heating. If it is stacked out of doors, the stacks should be built on stones, brambles, or, better still, on pillars, in order to keep them dry at the bottom, and allow a free circulation of air about them; and, finally, they should be very carefully thatched, to prevent the Flax being injured by wet. In this way the Flax will not only keep for years, but it is thought that the quality of the fibre is improved by keeping at least up to the third or fourth year after steeping. Flax, however, is sometimes dried by artificial heat, which is effected by placing it on kilns; this practice is very generally and properly condemned, as being highly pernicious to the fibre, impairing its quality, and consequently reducing its money value; and if the Flax has been properly steeped and *grassed*, no such drying is at all necessary, but to make it ready for breaking and scutching, simple exposure to the sun is all that is necessary.

BREAKING AND SCUTCHING.

The Flax is now ready to undergo the final operations of *breaking* and *scutching*, which have for their object the separation of the woody portion or shove from the fibre, so as to render it fit for the market. These may be done by the use of different very simple implements or contrivances worked by the hand, which are too well known to need description, or by machinery; and the preference given to the use of one or other depends on the circumstances of the Flax grower. It is by manual labour that the greater part of the Flax grown in Russia, Holland, and Belgium is dressed; and even in this country a good deal of Flax is so prepared for the market, though by far the greater portion is dressed by machinery; and it is generally admitted that less injury is done to the fibre by hand breaking and scutching than where mills worked by steam, water, or horse power are employed for those purposes. Manual labour, however, has this great drawback, that it occupies much more time than machinery, and consequently the latter is becoming more and more generally employed; and improved and powerful breaking and scutching mills have been recently erected in various parts of the country, which, though still susceptible of further improvement, effect a great saving of time and labour in preparing the Flax for the market. But the circumstances of the Flax grower will influence him as to whether he should handscutch his Flax, or send it to where it can be scutched by machinery. Hitherto it has been generally considered that it is more advantageous for the small farmer and cottier to handscutch his Flax, and for the larger farmer to employ machinery, manual labour being too tedious and expensive where much Flax has to be scutched; but the increased facilities which are now being introduced into this country for having Flax scutched, owing to the construction of improved and portable scutching mills, as well as of those which have been recently erected in different parts of the country, will, there can be little doubt, make the practice of scutching by machinery that universally adopted in Ireland, whereby so great a saving will be effected in the time and labour consumed in this process where manual labour is alone employed.

THE COURTRAI SYSTEM OF MANAGING THE FLAX CROP.

In addition to the foregoing directions as to the management of the Flax crop, it may be well to notice here the practice which is followed with great success in some parts of the Continent, especially in that district of Belgium which is in the neighbourhood of Courtrai, and consequently that mode of treating Flax is usually designated as the Courtrai system. This consists in carefully drying the Flax in the field after it is pulled; and when this has been sufficiently accomplished, it is ricked or stored up till the following spring, when it is considered fit for steeping. The chief peculiarity of this system consists in the mode in which the Flax is dried and ricked, which are accomplished in the following manner:—The handfuls of Flax as soon as they are pulled are set up in long narrow stooks, which are made by resting the tops against each other, the root or butt ends being placed on the ground spreading outwards like the sides of the letter A. These stooks are made from eight to ten feet in length, and a strap keeps the ends firm together. Being thus exposed to the action of the air and sun for six or eight days, according to the state of the weather, the Flax will be sufficiently dry to be tied up in bundles of the size of small corn sheaves; these are then made into a rick, which is usually constructed in the following manner: two poles are laid along the ground, parallel to each other, at a distance of about a foot apart, and in a direction north and south, so that the sun during the day may get on both sides of the rick; at the ends of each of these poles a strong upright one is placed.

The sheaves of Flax are then laid at right angles across the parallel poles, placing the tops and roots of each bundle alternately, and making the breadth of the rick the length of the sheaves; in this way it is built up to the height of about seven or eight feet, when it is finished by placing a single row of sheaves on the top lengthwise, or across the others, and then putting another row as before, the tops of all being placed the same way; by this means the necessary inclination or slope is given to throw off the rain; and being thus constructed, the rick is finally covered or thatched with a little straw, which is secured by a rope or otherwise. In this way the Flax may be safely kept for months, till it can be stacked or put in the barn; but in either case it is usual to remove the seed in the winter previous to the steeping of the Flax, in the spring, or early part of summer. Whatever advantages this system may possess, it certainly has this drawback, that a much longer time is required before the Flax is finished and ready for the market than where the system usually adopted in this country is followed, viz. of steeping the Flax immediately after being pulled. It is, however, a question whether the very superior quality of the Flax which comes from those parts of Belgium where this system is adopted may not in some degree be more or less connected with the practice of drying the Flax previous to its steeping, whereby certain changes are produced in the Flax, which render the fermentative action more slow and controllable during the subsequent process of steeping, and effect other alterations, whereby a fibre of better quality is obtained, which more than compensates for the longer time occupied in the process; at all events, the experience of the Flax growers of those districts where this system is followed, has no doubt shown them that, circumstanced as they are with regard to soil, markets of consumption, &c. this method of treating Flax is the most advantageous for them to pursue.

XVII.—SOME HINTS ON THE SUCCESSFUL RECLAMATION OF BOG.

By GEORGE ELLIS, M. B.

[Read before the Royal Dublin Society, December 19, 1864.]

IT has been so frequently asserted, as if it were a generally admitted fact, that the bogs of Ireland are capable of reclamation, and by an outlay of money may be made to yield profitable returns, that, on the credit of this assertion, persons have been induced to commence drainage operations without due consideration, and have expended considerable sums in this way without arriving at the satisfactory results they anticipated. I speak here of those large tracts of pure unmixed peat bog used for the supply of fuel. Every one knows that on the flanks of most of these bogs, where the earthy material of the neighbouring land begins to mingle with the peat, there is a narrow border capable of remunerative reclamation, and this has been already effected in numberless instances by the occupying tenants themselves. But the reclamation I refer to here is of a more difficult character. First of all, after the general arterial drainage of the district, if that should be necessary, comes the thorough drainage of the bog: this, no doubt, may in general be pretty easily accomplished at no great cost, by skilled superintendence and a good supply of labouring hands, particularly if the sides and bottom of the drains are found sufficiently consistent for the use of tiles. Next comes what is called the gravelling, that is, the covering of the surface, to a depth of at least four inches, with the solid material found at the bottom of most bogs, usually in the form of a blue or yellow tenacious clay. There is sometimes to be had in this situation a calcareous marl, consisting chiefly of carbonate of lime, which is invaluable for the purpose; but, unfortunately, it is not always found in connexion with bog. This gravelling of the surface is considered an indispensable process; the cost will vary much with the locality; often the gravel must be raised from considerable depths by pick and crowbar, or carried from hills at some distance; and if in such cases the population be scarce, and labour consequently high, the owner should calculate carefully before proceeding further. In the absence of the marl I have mentioned, or of lime in some other form, the burning of limestone becomes a necessity; and if limestone cannot be obtained, I think he will be a bold and sanguine speculator who will undertake the reclamation. Let us, however, suppose that all the requisites I have mentioned are available, and that the surface is at last fitted for green crops, turnips, or mangels, and potatoes. The means of manuring well a large tract of this inferior soil must now be provided, and to some persons may prove a serious difficulty. Let us now proceed still further, and suppose that the green crops have grown satisfactorily, and that they have been succeeded by oats or rye, with grass and clover seeds. At the present price of grain, I need not dwell on what the value of this crop will be after deducting the cost of labour; the grass, however, which follows will be found highly valuable in supplying hay for winter feeding, and afterwards as pasture for young cattle of a light description. For the next three or four years the expenditure for labour will be very trifling, little more than what is required to keep fences in order, open drains clean, and for the general care of young stock. This period will be found satisfactory to the farmer's pocket, and if this state of affairs were only permanent, the reclamation of the bog would be decidedly successful; but now comes perhaps the greatest difficulty of all; after a few years the grass begins to fail, the whole rotation must be recommenced and gone over again—green crops, cereals, grass, and clover—with equal expenditure as at first for labour, manuring, and liming, and the farmer will now begin to reflect, and calculate his profits.

Having made these preliminary observations, I will now relate, with your permission, the history of a piece of reclamation of this kind on rather a moderate scale, which was completed about fourteen years ago, and has proved up to the present time fully remunerative.

There is on the sea coast of the country of Leitrim a limited district, remarkable chiefly for its numerous and poor population. For the greater part of a century they had been allowed, like many others similarly circumstanced, to subdivide their little holdings much as they pleased, as they always paid their rents without much difficulty, and they increased and multiplied accordingly. The population of one large townland there of about 670 acres, including much bog in which the reclamation I refer to has been carried on, was by the census returns of 1851, after the famine had done its worst, 479, males and females included. In the spring of 1849 distress was at its height; the people were reduced to the last extremity, and the owner was much perplexed. Two courses were open to him: by simply waiting, with a little pressure and a small outlay of ready money, this starving population might have been made gradually to disappear, their homesteads might have been unroofed as in other places, and the land, which is of excellent quality, turned into pasture; or, the owner might sympathize with the struggles for life of the sufferers, allow them to remain in their holdings, and, by providing employment, furnish them with the means of assisting themselves by their own labour. Fortunately the latter course was taken; a grant of £900 was obtained under the Land Improvement Act, and work was soon commenced. Besides the thorough drainage of some good land which required it, and of which I shall not speak further, there was taken in for reclamation a tract of about 90 acres of bog, partially cut for fuel, black, barren, and useless for any other purpose; and to this portion, as bearing on the subject of this paper, I shall now confine my remarks.

The operations of levelling, thorough draining, gravelling and fencing, were effectually performed under the periodical supervision of the Commissioners, who, through their able inspector, Mr. Prendergast, afforded every facility and assistance for the period of three years, during which the work lasted. The tenants on the land were, I need not say, quite numerous enough to supply the requisite amount of labour, and soon, under skilful training, became adepts in the art of reclaiming.

Fortunately the stiff yellow clay at the bottom approached the surface, here and there, and furnished the means of gravelling sufficiently, though this part of the work was slow and laborious. Limestone is found here on the rocky coast, and a large limekiln was soon erected. Each field, on being completed, was prepared for a turnip crop. The only manures used were seaweed and some turf ashes obtained by paring off the coarse and rugged surface of the peat, and burning it in heaps upon the field, the gravel being carefully removed when this was done. Considering the cost of this simple and primitive mode of husbandry, there was no cause for being dissatisfied with this the first year's crop, particularly as the main object in these cases is to bring the soil into a state of preparation for laying down with grain, grass, and clover seeds,—an object which was accomplished, in the first reclaimed portion, the following year. By a liberal supply of lime, after a fair crop of rye the clover grew well, and the grass surpassed expectation. The well-known fiorin grass, *Agrostis stolonifera*, was found to grow luxuriantly and was easily propagated by cuttings. A large crop of hay was secured, and young cattle afterwards placed on the pasture. During the three following years the annual outlay for this portion was at its minimum. The cattle throve well, and the profit from their sale was considerable.

If, by the simple processes I have described, waste bog could be converted into permanent pasture, there would soon be very little of this commodity, thus favourably circumstanced, left unreclaimed in Ireland. Nature, however, will have her way. After the third or fourth year the grass in the fields first laid down began to fail, and the soil required to be turned up again.

Now, whether in a series of years this rotation would remunerate the owner fairly, considering the low price of grain, and the ready money expenditure necessary for all labour (including the gathering, carting, and spreading of the seaweed, and all other requirements for this kind of tillage farming), I have had no means of ascertaining experimentally; as at this period a new arrangement was made, by which the same system of rotation was carried into effect with very little expense to the owner; and to this new arrangement I wish particularly now to invite attention.

The potato disease was at this time very destructive to crops planted in clay land; while it began to be noticed that bog soil seemed to have some preservative quality, which protected at least a considerable portion of the crop. Some of the men were anxious to make trial of it; and, in compliance with their wish, those fields where the grass first began to fail were submitted to the experiment. Each field was marked out in roods, which were apportioned to those who desired to take them for the season's crop, or, as it is called, in conacre. Each man manured his rood plentifully with seaweed; and the potato crop which followed was the best and safest that had appeared in that neighbourhood for many years, while the clay land adjoining suffered in the usual way. The conacre rent, at the rate of £3 the Irish acre, was cheerfully and well paid; the only outlay by the owner, for this year, being the cost of supplying lime, which, however, also served him indirectly, by improving the condition of those tenants who were employed in the collecting and burning of the limestone. The same fields, in the following year, yielded equally good potatoes at the same rate of rent, without any further addition of lime; and in the third year they were again laid down by the owner with oats, grass, and clover seeds, yielding, as before, after a grain crop which was not considerable, an abundance of hay and good pasturage.

Successive portions of the rest of the bog were treated similarly, and up to the present time the same rotation and system of conacre have been observed, with satisfaction and benefit to employer and employed. In fact, this piece of waste bog alone, by the treatment it has undergone and the system adopted, may be considered a permanent improvement, returning to the owner, for the outlay of about £500, a clear addition of at least one hundred a year, besides no inconsiderable benefit to the numerous small occupiers residing on the property.

Now, I think it is pretty evident that the system I have described is only applicable under certain conditions, and that these conditions present themselves only in certain limited areas, occurring only on those parts of the coast where the population is very numerous, where lime is easily obtainable and seaweed abundant, and where bog is found of such a nature and position as to admit of thorough drainage and good gravelling, at a moderate cost. I believe that much disappointment has arisen from undertaking the reclamation of bog not possessing these advantages; and that much money has already been spent in futile attempts to render such bog reproductive. In one large estate, belonging to a distinguished nobleman, whose liberal efforts in this way are to be admired, many thousand pounds must have been expended and utterly lost in bog reclamation. He has, however, enabled a great number of small holders to emigrate; and, by planting and thorough drainage of large tracts of poor and sour land, has effected a visible improvement in all that part of the country; but the bog on which so much money had been wasted has already returned to its original condition, and will, perhaps, remain bog to the end of time.

I do not express an opinion as to whether that mode of improvement may not, in the end, be more beneficial to the country generally. Under the circumstances, I believe nothing better could have been done in the instance referred to. All I desire to affirm is, that on certain parts of the Irish coast, where there exists a sort of local plethora of population, and where tracts of useless bog are found in connexion with such natural advantages as limestone and seaweed, there this numerous population, instead of being an obstruction and a difficulty, may be utilized, and treated as a chief element necessary for the profitable application of such natural advantages in the reclamation of these otherwise useless wastes. As a relief to this local plethora, this method will certainly be found more agreeable to all parties than the otherwise perhaps unavoidable one of blood-letting, as it may well be called, and purgation—the forcible removal of a superabundant small tenantry by process of ejectment, combined with the expenditure of pecuniary inducements besides.

Unfortunately these crowded populations are found to be prolific in the ratio of their poverty, and after a few years the increase of births over deaths furnishes a new difficulty, not easily dealt with. I am glad to say that in the district I speak of a disposition has shown itself among the young people to seek employment in the great manufacturing towns of Scotland; Glasgow appears to be the favourite resort of the more adventurous, and I have little doubt that after some time, by the spread of education, and increased facilities of communication by railway and steamboat, an effectual drain shall be established, which will keep the pressure on the land, even in the most populous districts, at a safe and endurable amount. The rail, the steamboat, and education seem destined to become the true elevators of the lower strata of our social life. If manufactures do not come to us, we at least can go to them, and we can lose nothing, while we gain much, by the freest intercourse and closest union with the sister island.

But there is one kind of manufacture still left to us everywhere in Ireland in which we need not fear competition, and which, if developed as it ought to be, and I think must be finally, will perhaps enable the small occupier of five Irish acres to live and thrive, and upset the theories of those high and respected authorities who consider thirty acres the minimum on which an Irishman ought to live; and as it seems to me to have a connexion not very indirectly with the subject of this paper, I may be pardoned for dwelling on it a little, in conclusion.

I think it is now tolerably manifest, from the experience of many years past, that Ireland as a corn-producing country can never again enjoy a very profitable market; grain has fallen below remunerative prices, and, unless in those exceptional years when there may occur a general scarcity in Europe and America, must always continue very low. Free trade, as we all know, has accomplished this all-important result, with immense benefit to the interests of Great Britain and of the world; and, though inflicting immediate injury on the Irish farmer, will ultimately, I have no doubt, conduce very greatly to his prosperity. It may be also assumed, I think, that all the other vegetable produce of the tillage farmer in its raw state, if sent to market in that condition and sold, if that were possible, at the market prices of the present day, would never very much enrich the producer. Yet the small holder is now surprised and bewildered, because with his potatoes, and his oats, and the pig, his only animal production, he finds the difficulty so much greater now than formerly of feeding his family, keeping out of debt, and settling with his landlord.

But the grazier is now the thriving man. Unlike the tillage farmer, he converts *the whole* of his raw vegetable materials, grass, hay, and green feeding, into animal products, and is always pretty sure of a ready sale at good prices. In these articles of consumption, with the best markets in the world, the great manufacturing and commercial towns of Great Britain, always close at hand and always open to him, he need never fear foreign competition. Now, *if improvement is ever to take place in the condition of the small holder, I think its direction is thus plainly indicated to us.* There is a great variety of animal substance into which *the whole* produce of a small farm (flax of course excepted) might be converted. Besides the indispensable pig, with its numerous litters, there is the sheep with its wool; butter, of course, always now profitable; poultry of all descriptions, with their eggs and feathers; and, above all, the breeding and rearing of young stock, to be afterwards transferred to the grazier's hands. For the production of all these marketable articles there is also a great variety of vegetable substances, of some of which the small holder has hitherto had little experience. There are the great flesh-producers, the bean, the pea, the vetch, and the clover; there are the mangel, the turnip, the carrot, the parsnip, and the cabbage, as well as the potatoes and oats. We are familiar with the fact that even a small garden may be made by skilful treatment to yield, in proportion to its size, a great quantity of these vegetables; and surely a farm of from five to ten acres of good land in the hands of an industrious man, with a large family of healthy children (the larger the better), ought to give full employment, under this system, to his whole household at all seasons of the year, and amply repay all the labour expended on it. The manure would return much of the produce to the land. The breeding and rearing of young stock would be the specialty of the small holder; the difficulty of supplying this prime necessary to the grazier would not then be felt as it is so severely at present, and butcher's meat would probably be manufactured with profit at a price that would enable Ireland to exclude the foreigner from the British markets by a sound, healthful, and legitimate species of manufacture peculiarly her own.

The difficulty of introducing any new method so opposed to long confirmed habit would, no doubt, be great. To leave the supply of the grain market entirely to those foreign nations, who are able to produce a better and cheaper article than we can, may appear, indeed, sufficiently in accordance with common sense; but the substitution of animalized products will require so much more industry and unremitting attention than the old plan, that any advance in this direction must be slow. The necessity for the erection of sheds and enclosures would be another obstacle to the small farmer, but I need not enter into details. I have only introduced the topic here as a theoretical opinion, in the hope that practical men, having large experience, and a close acquaintance with Ireland and its people, may be induced to turn their attention to the improvement of the small holder in this or some other better direction, and perhaps to give us the result of their experiments at some future day.

XVIII.—NOTES ON THE GENERAL GLACIATION OF THE ROCKS IN THE NEIGHBOURHOOD OF DUBLIN. By the Rev. MAXWELL H. CLOSE.

(Plate V.)

[Read before the Royal Geological Society of Ireland, May 11, 1864.]

IT has long been known that the phenomena of rounding, smoothing, and scoring of rock surfaces, now almost universally attributed to the action of ice in some shape or other, are well exhibited in different localities round Dublin. In the "Journal" of our Society, and in the Explanations of Sheets 102 and 112 of the Geological Survey Maps, striations and other marks of abrasion are recorded as occurring on the rocks in several places along the Drogheda Railway, on Lambay Island, at Howth, at Killiney, and on Bray Head.* Many of the particulars about to be described have been, I know, observed by different persons; but I am not aware that any tolerably *connected* account of them has been given. Some such connected and sufficiently detailed account is, from the nature of the case, often necessary to secure the correct interpretation of the phenomenon in hand at particular places.

This paper treats especially of the *general* Glaciation of the neighbourhood. The subject presents in this district two points of particular interest. The general glacial stream has here invaded what was doubtless the domain of the local ice-system of the Dublin and Wicklow mountains; and the relations of the two might be here ascertained, if we had sufficient evidence to go upon; and, moreover, it is interesting to observe, as the evidence fully enables us to observe, how the current, after passing across a considerable extent of plain country, has been affected by the obstruction of the mountains.

It seems best to state at once, though reasons cannot now be given without anticipating, that this paper has been written under the conviction that that current consisted of *glacier* ice, which probably covered the greater part of the country, and hereabouts came from the W. N. W.

The small accompanying map, Plate V., will give a tolerable general idea of the phenomena in question, but it may be well to point out more in detail the places where those phenomena present themselves. In giving the directions (true, not magnetic) of the striations, &c., it will be sufficient to set down the points *from* which they run.

In the railway cutting at Donabate, at a short distance from the station, on both sides of the railway, but especially on the western, where is the fairest example, scorings occur on the greenstone, direction

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* It is necessary to note an evident typographical error in our "Journal," vol. iii., p. 61. Professor Oldham is there made to say, in an abstract of a paper by him, that he found rock scorings on Bray Head, N. 23° E., and S. 23° W. This has misled Mr. Jamieson ("Journal of the Geological Society," London, 1862) into supposing that that part of the country has been swept by ice from the bed of the Irish Channel. It is certainly true that at one place, under the lee side of the hill, the striations have curved round almost into that direction; but on comparing this with another paper, by Professor Oldham, vol. iii., p. 132, it will be seen that he must have written N. 23° W., and S. 23° E.; which is the direction of some good grinding to be seen on the upper part of Bray Head.

N. 57° W. In the churchyard of the Roman Catholic chapel at Donabate, on Old Red Sandstone conglomerate, the mean or normal direction is about N. 70° W. On the shore at Portrane, on Silurian slaty rock, the striations are to be seen peeping out from under the bank of drift: owing to the inequalities of the surface, they vary a little on each side of the mean direction, N. 66° W.; at one spot they run nearly at right angles to this, affording, apparently, one of the very few examples of cross striations. In the large quarry, one-fifth of a mile S. S. E. of the town of Malahide, on Carboniferous Limestone, the direction is N. 82° W.; and in two small quarries, three-fourths of a mile S. E. of the town, on the same rock, the normal direction is the same. On the island of Ireland's Eye the masses of vein-quartz occurring in the Cambrian quartz rock are, in many places, well polished and striated; direction N. 63° W. On the Hill of Howth, not merely the vein-quartz, but the Cambrian quartz rock itself and the grits and slates have well retained, in many places, the marks of grinding, in the rounding, smoothing, and scoring of the surface. Striations are to be seen at one-fourth of a mile east of St. Fintan's Church; at a short distance south of the summit of Kilmartin Hill, at an elevation of 500 feet; on the top of Carrickbrack Hill, a very good example; near Drumleck Point, elevation about 40 feet; a little to the north, and also to the south of Kitestown; at one-fourth of a mile S.W. of Casana Rock, where the striations (to be referred to again) run *down hill;* near the Nose of Howth; and, as I am informed by Mr. Westropp, on the shore near Sutton Station, the rock in this case being Carboniferous Limestone. The striations are remarkably parallel over the whole of the peninsula, whether on the level ground, at the top, or on the sides; the normal direction for the hill being just about N. 60° W. In a large quarry half a mile north of Raheny, and in a small quarry seven-eighths of a mile north of the same place, the limestone is scored in the direction N. 48° W. In a quarry three-eighths of a mile due north of Finglas Bridge, the same rock has striations whose normal direction is N. 64° W.

In all the cases now mentioned the striations have a very striking nearness of direction; their variations are entirely due to immediately local inequalities of surface. Turn we now to the south of Dublin, where we shall find great changes of direction connected with the larger physical features of the district. At one-eighth of a mile S. E. of Crumlin House the rock is limestone, striations N. 82° W. At three-eighths of a mile N. by E. of the cross-roads at Roundtown the same rock has scorings N. 74° W. At Dundrum, just to the south of the church, the granite is well rounded and scored, N. 60° W. In different places near Murphystown, granite, N. 54° W. At Stillorgan reservoir, and in different places about Foxrock, granite, N. 43° W. The normal direction of the striations on the three Killiney Hills (granite and mica slate) seems to be precisely the same as the last. A most striking example of grinding occurs just outside the N.W. corner of Killiney Park on the southern slope of Rochestown Hill. Besides scorings covering many square yards of mica slate and granite, there is a straight groove or moulding, nearly two yards long, nine inches wide, and 2½ inches deep. This and the parallel scorings run obliquely across the edges of the highly inclined beds of mica slate. Some small masses of quartz, having better resisted the abrasion, stand up a little from the surface, and have given rise to some miniature specimens of "crag and tail," which show not merely the line of the grinding, but the direction of the motion in that line. On the same hill are many striking *roches moutonnées*, but of these we shall speak again. Marks of grinding occur likewise on the middle, or Killiney Hill proper. On the N.E. shoulder of Dalkey Hill the striations can be seen near a wall opposite Ardsunnas Cottage, on the granite; also in a small quarry one-fourth of a mile N. E. of the summit of the hill, running straight up the hill; to be referred to again. At a short distance N. and N. E. and S. of Ballycorus chimney shaft the normal direction of the scorings, on mica slate and vein-quartz in granite, is due north, elevation 760 feet. In three or four different places in the wood on the east side of the Scalp the direction, on granite vein-quartz, is the same. Obscure but indubitable traces of grinding can be seen on the upper parts of the sides of the Scalp itself, showing that the current has flowed through that gorge. On the summit (912 feet) and sides of the knob which forms the top of Carriggologan Hill, or Shankill, on Cambrian quartz rock, especially on the quartz veins, the smoothing and striation still survive; the normal direction for that eminence being N. 8° E. Near the old church of Rathmichael the direction, on eurite and mica slate, is N. 46° W., evidently on account of the position of that place on the hip of Shankill.

The glaciation of Bray Head presents a peculiarly interesting and somewhat complete study in itself, to which we must return again; we shall now only note that the striations may be seen in a great number of places all about the hill, sometimes on the Cambrian grits and slates, but for the most part on the quartz rock and quartz veins; in different places along the sea side, both below and above the railway (see especially the northern end of the southernmost tunnel); near the small ruined church overlooking the southern end of Bray strand; on the top of the eminence, 653 feet; on the top of that close by to the south, marked on the 6-inch maps, 668 feet, where is some splendid grinding; in several other places along that quartz rock ridge; *in the depression* to the eastward of Ballynamuddagh farm-house; and in several places along the crest of the quartz rock ridge which rises to 793 feet, the highest point (itself scored) of Bray Head. The normal direction of the striations for the hill is N. 31° W., as appears on comparing those cases where there is least deflection arising from local conditions. On the little hill near Windgate, 532 feet, the scoring on quartz rock has the same direction almost exactly; as also in Kilruddery Deer Park, on the east flank of the Little Sugar-loaf. A careful adept will, I believe, be able to recognise on the greatly weather-shattered quartz rock on the very summit of that hill (1120 feet) some remains of the old glaciated surface which have escaped destruction. I believe even that the striation can be seen at one spot, its direction being N. 13° W. On the north-west side of the Little Sugar-loaf, three-eighths of a mile south-east of Hollybrook House, there is some well-ground quartz rock, the direction of the scoring being N. 24° E., evidently on account of the position of the spot, the current there having been shouldered off by the hill. On some quartz rock, three-eighths of a mile west by north of Kilmacanoge, the striations are N. 25° E.; the stream swept in a curve round the north-west base of the Little Sugar-loaf, into the valley of Kilmacanoge. In that valley we find, on the slope of the Great Sugar-loaf, and about west of its summit, striations running in the direction of the valley, and therefore nearly parallel to those near Kilruddery and on Bray Head. In the same part of the valley, and in the bottom of it, is a considerable extent of well-smoothed quartz rock, the striations on which have been almost, but not quite, obliterated by the weather. The ridge or hill on the north side of the Rocky Valley presents striations on the vein-quartz on its summit, 802 feet, and in different places for the distance of a mile, their general direction being about N. 44° E. The stream was here deflected by the mass of the Great Sugar-loaf; it must have flowed round the north-west flank of that hill, and on over the *col* or saddle (about 900 feet high), near Ballyremon Commons and the "Long Hill." At Greystones, along the west side of the railway, and north of the station, and also on the shore, at the north end of the village, there is some splendid scoring on Cambrian slates and grits, the normal direction for that place being N. 3° W. We find here an example of a second set of striations crossing the normal ones on the same surface, on fine clay slate, both being inclined to the edges of the cleavage. An adept will detect still surviving striations parallel to the normal ones at Greystones, on the quartz veins near the summit of the hill, 725 feet, 1¼ mile due west of that village. Passing on southwards, we find that remarkable boss of quartz rock at Kilcool village, presenting striations whose normal direction is N. 6° E. Proceeding thence along the road due south, we find, at the distance of 1¼ mile on the left hand, and 1½ mile on the right hand, near Leabeg, on quartz-rock and quartz veins, striations whose normal direction has reached N. 18° E.

We shall now proceed no farther in this direction, and that for three reasons:—We have already transgressed our limits, and gone beyond "the neighbourhood of Dublin;" moreover, there is little friendly quartz rock remaining, to which we might look with some degree of confidence for recorded marks of grinding;* and lastly, and above all, what does remain seems to warn us, if we read its record aright—which is rather doubtful, however—that a step farther may entangle us with the *local* glaciation of the Wicklow mountains. (*See Appendix, at end.*)

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* When looking for glacial striation on the quartz rocks and their vein-quartz, it is necessary to guard against being deceived by the (structural) slickensides which occur so frequently among those rocks; but no person whose attention had been once drawn to the matter could, with ordinary care, mistake the one for the other. There are several cases on Bray Head and Shankill of glacially striated slickensides, the two sets of striæ crossing each other, and perfectly distinguishable.

We turn, then, for a moment to the country about fourteen miles west of Dublin. At 2¼ miles south-west of Maynooth, in the ditch on the right side of the road, there are to be seen scorings on the limestone, their direction being N. 22° E. In a quarry on the west side of the hill, marked on the Ordnance Maps 312 feet, 2½ miles nearly due south of Maynooth, the limestone has striations N. 19° E. These two examples are 1⅓ miles apart. In the quarries, half a mile south-west of Clane, scorings can be found in several different places. They vary in direction a good deal, owing to the very uneven surface of the rock; but the normal direction for that place is clearly just about N. 46° E. On Oughterard Hill, near Lyons, at a short distance N. N. E. of the Round Tower, and also three-quarters of a mile north-east of it, the slaty Silurian rock has striations N. 44° E. At the last-mentioned spot there are cross striations north, though not on the same surface with the others. *These* are rather indistinct, and the real nature of them is doubtful. The instances now mentioned in this neighbourhood form an equilateral triangle, whose sides are about 5½ miles in length.

We must now notice some parallel furrowing of a different kind. On reference to the shaded Sheets of the inch Ordnance Maps, containing the environs of Dublin, it will be seen that the country just now referred to between Maynooth, Clane, and Oughterard, has a number of ridges crossing it parallel to each other, and to the rock striations nearest to them. Some of these ridges, *e. g.* the hill above mentioned, 312 feet, 2½ miles south of Maynooth, are chiefly, as it seems, composed of solid rock, and shaped up by drift. Some, *e. g.* the hill at Ardrass, 1¼ miles north-east of Straffan, whose summit is marked on the Ordnance Map 308 feet, are entirely composed of drift. The ridge now mentioned is a very well defined and noticeable one, perfectly parallel with the others, blunt at its up-stream end, and tailing off gradually in the opposite direction, distinct as to its composition and structure from an esker, yet somewhat similar in form. It is described by Mr. Du Noyer as "an esker-*like* mound."

Proceeding northwards from Maynooth, we find all the country from about Dunshaughlin to the sea at Portrane and Malahide, and over a width of several miles, in parallel ridges and troughs. In some parts this conformation is very striking; it is apparent even on the unshaded maps, from the number of streams, roads, and fences whose directions have been determined by the shapes of the ground. These ridges are parallel to the rock scorings at Portrane, Donabate, Malahide, Finglas, and Howth, and nearly at right angles to those south of Maynooth and their associated scorings. (*See accompanying map*, Plate V.)

No one can doubt, then, that these ridges and troughs and the rock striations are effects of one and the same cause, since they always correspond with each other as to direction, whatever that direction may be. Now, it has never been shown that moving water can score rocks in parallel lines by sweeping detritus along over them; neither sea waves, nor rivers, nor violent torrents (as Mr. Jamieson has shown in the case of the bursting of the Crinan Canal reservoirs) are able to effect this. Water currents, then, have not produced the rock scorings, and therefore they have not produced the ridges and troughs. That agency has indeed been at work, and, apparently at the expense of the parallel ridges, which have been sometimes partially, sometimes entirely obliterated thereby, has formed some esker mounds in the district, and, a little south-east of Trim, an esker ridge, five miles long, of most distinctive character, and inclined to the others at an angle of about 20°.

Since the parallel ridges and the rock striations have been produced by the same agent, which must have been the glacial stream, we may avail ourselves of the evidence afforded by them jointly in investigating the course of that stream.

Let us look for a moment beyond our limits, and note that the north-westerly and south-easterly ridging may be traced backwards, most distinctly, from Dublin and Meath into south Cavan, Westmeath, Longford, and south Leitrim at least. It largely affects the outlines of several of the lakes in the district now mentioned. The strike of the ridging makes a continuous curve towards the north as we follow it backwards into Leitrim, so that there its direction is north by west and south by east. Mr. F. J. Foot, of the Geological Survey, has kindly informed me that this parallel conformation of the country is very remarkable near Longford, and that the rock-scorings to be seen four miles east of that town correspond in direction with the ridges and troughs.

We have then evidence of the continuous course of that part of the glacial stream with which we are concerned, by which we see that, having flowed from beyond Longford, across the intervening plain country towards Dublin, it became divided by the resistance of the mountains, the place of division being well defined, and situated about four miles north-east of Maynooth (*see map*); one part turned sharply to the right, and flowed towards the S. S.W. by Clane; the other continued its course straight onwards for a little, and swept round the northern end of the Dublin and Wicklow range of mountains, turning gradually southwards into the wake of the mountains, and running along, for some distance at least, under their lee, nearly parallel to the present coast line. But while sweeping round, it also swept, partly at least, over the end of the range and among the outlying hills thereof. It has left its traces in *roches moutonnées* and ground vein-quartz, at the height of just about 1000 feet on the north side of the Three-Rock Mountain; its marks show that it flowed over the top of Shankill, and over and through the Scalp, into the wide valley of Enniskerry and Powerscourt, over Bray Head, and, as I now firmly believe, over the top of the Little Sugar-loaf (1120 feet). We needed not its traces in the valleys of Kilruddery and Kilmacanoge to assure us that it has swept through those passes. The striations near the Rocky Valley show that it must have passed between the Great Sugar-loaf and Douce into the valley of the Vartry River.

As the glacial stream passed along, it did much more than merely score the rocks; it ground them down into *roches moutonnées*, which in some places are very striking and characteristic. See, for instance, those on the up-stream side (the north-west) of Rochestown Hill, as also the rounded surface of the north-east shoulder of Dalkey Hill, opposite Ardsunnas Cottage. The rock there, granite, has stood well to be ground, instead of being ripped away in blocks; and the amount of pure abrasion that it has undergone to superinduce its present form of surface has evidently been enormous. The striations have been removed by weathering, except in a few places, where they are still perfectly distinct. Dalkey Island is well worth a visit, if only for the sake of its rounded rocks. The contrast between a down-stream view, in which only the rounded sides of the rock bosses are visible, and an up-stream view, in which their rough lee sides are visible, is exceedingly striking: the scoring has survived only in two places—near the battery, and near the martello tower, on a quartz vein. It is interesting to compare, on that island, the effects of glacial and of marine denudation which are presented in juxtaposition, and to note the difference.

The rounded aspect of the naked summit of Shankill, as seen especially from the west, is very remarkable; the flowing and swelling shapes of the whole of that hill have been evidently rasped out of granite, highly-inclined mica slate, and intractable quartz rock. The humps and prominences on Bray Head, composed of quartz rock, are very decidedly rounded, on the large scale, as well as on the small; this is very visible, to a slightly practised eye, from a distance of a couple of miles, especially if the light be favourable. This rounding, as before, is only on the up-stream side of the prominences. The rounding on a large scale was, doubtless, for the most part, chiefly effected by ripping the rock away in blocks; and it might, therefore, often be very observable, though the rock might have suffered comparatively little from pure grinding.

Some other apparent effects of the glacial stream remain to be noticed; but it will be best now to consider what evidence this district affords as to the nature of that stream. If, then, it were glacial, it must have consisted, not of floating, but of land ice. This conclusion seems *necessitated* (1) by the regular determined flow of the striations, whether regarded on a wide or on a closer view; (2) by the marks of *steady* up-hill grinding on Dalkey Hill and Bray Head,* for instance; though, of course, a floating mass impinging on a slope could force its foremost end a little way up that slope (3) by the marks of *down-hill* grinding on the lee side of Howth, as above mentioned; and on that of Killiney Hill, by Mount Eagle House; these, belonging unquestionably to the general glaciation, could not have been caused by any floating mass; (4) by the fact that striations are often to be found at a lower level than the up-stream ground in their vicinity; the scorings near Finglas Bridge, Raheny, and Portrane, and some on Bray Head, are thus situated. The case last mentioned seems to be worthy of special observation. That great band of quartz rock on Bray Head which forms a prominent ridge, one of whose summits is marked on the Ordnance Maps 653 feet, has on its lee-side a depression or slight valley running parallel to it across the main crest of Bray Head; in this depression is situated the farm-house of Ballynamuddagh, and about 256 yards to the E. N. E. of this house we find some smoothed and scored rock. The striations are parallel to the others about the hill, and belong indubitably to the general glaciation, and point directly towards the ridge above mentioned. It is manifest that the scoring agent has flowed over that ridge, and down into the depression on its lee-side, more than eighty feet below, within a distance of a quarter of a mile, which, of course, could not be done by ice floating in the ocean. An inspection of the place will show at once that, if floating ice has ever grated across the glaciated rock now spoken of, it must *necessarily* have moved in a direction nearly at right angles to that of the actual striations on that rock. We may observe that it seems very hard to believe that the naked summit of Shankill and the naked north-east shoulder of Dalkey Hill could have been ground into their present shapes by floating ice. All the striations *hitherto mentioned* are evidently related to one and the same cause; they have been produced by a continuous stream whose sinuosities are clearly explained by the shapes of the ground. If, then, any have been traced by land ice, all must have been so; and that ice has been, in the neighbourhood of Bray at least, over 1120 feet deep.

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* It is interesting to note that the scoring agent has moved straight up the north-west side of Dalkey Hill, the inclination of the ascent being 11½°. Bray Head affords a more striking case still. The striations at the up-stream end of that hill give satisfactory evidence that the scoring agent has moved from the sea level, at the southern end of Bray strand, directly up the side of the hill, to that summit, whose height is 653 feet, in the horizontal distance of exactly half a mile. The inclination of the slope, as a whole, is 14°; but near the top the scoring agent has moved almost straight up a tolerably plane slope, whose length is twenty-seven yards, and inclination 28°. The striations are to be seen on the quartz in several different places on that surface; it is perfectly certain that the movement was upwards, and not downwards. These facts may throw some light on the question, whether the ice of a large glacier could go down into a hollow in the glacier's bed, and up again out of it at the lower end.

There are reasons for suspecting that at some period it was much deeper, probably before the time when the stream flowed as its present traces indicate. Whatever may be the real significance thereof, there are well-scratched pebbles in the limestone drift beside Caldbeck Castle, on Kilmashogue Mountain, just above the 1250 feet contour line; and close by Fairy Castle, on the summit of the Two-Rock Mountain, at the height of fully 1760 feet, there are several stones along a boundary fence, some well-rounded and as large as a man's head, of far-transported material, viz., limestone and a white sandstone.

There are some facts which make it scarcely rash to conjecture that at one time the glacial stream may have moved right across the long ridge of the Dublin, Wicklow, and Wexford Mountains, viz., the remarkably rounded outlines of those mountains, even to the summit of Lugnaquilla itself, 3039 feet, notwithstanding the great hollows or "prisons" which have been scooped out of its sides; the parallelism of the transverse valleys to each other, and to the direction of the undisturbed current north of Dublin; the straightness and better definition of those valleys on the east side of the mountain range; the fact that their *cols* are often situated to the west of what seems to have been the original position of the watersheds of the passes: the last two peculiarities are precisely what might have been superinduced by a glacial flood of sufficient denuding efficacy, coming from the north-west, *partly dammed-up* by the long mountain barrier, and pouring over the crest thereof down the steeper slope of its lee side. It seems not imprudent to suspect that such may possibly turn out to be the case, when we reflect that the striations across the summit of Shiehallien, in Scotland, 3533 feet above the sea, and across the top of Mansfield Mountain, Vermont, U. S., 4848 feet above the same level, have been attributed to the action of land ice by Agassiz and Professor Dana, respectively. If the glacial stream did ever flow across the Dublin, Wicklow, and Wexford Mountains, it was doubtless before the time when that barrier was able to split the stream at the distance of about eleven miles, near Maynooth.

There are some features, besides those already noticed, which seem to be the result of glacial denudation. The country between Dundrum and Dalkey, and Kingstown and Carrickmines, has some wide ridges and troughs running parallel to the rock scorings, *e. g*, the ridge along whose crest Rochestown Avenue, near Killiney, runs; that of Glenageary, that of Galloping Green and Foxrock, &c. It is clear, from the striations upon the Killiney Hills, and also from the general facts, as shown on the map about that part, that the glacial movement has not been there determined in direction by those ridges and troughs, but that, if there is any relation, they are dependent upon it.

That remarkable gap, the Scalp, cuts across a ridge which is transverse to the direction of the glacial movement. It is almost exactly parallel to the scorings mentioned above, to the east of it. The ice has flowed, as its traces show, through that pass; it would there act, owing to the shape of the ground, with concentrated force. It is the property of actions, like the glacial, working in one direction, that if, owing to some cause or other, they have succeeded in working a slight hollow or channel in a particular place, they will tend to work with increased efficiency in that channel when produced: this fact constantly presents itself to our notice, and the reason of it is obvious. It accounts for the deep grooves and flutings that are sometimes ground (not ploughed) out on well glaciated rocks. The Scalp may be compared to what we may sometimes see, a single groove of this sort; but yet it is not all alone, for 1½ mile to the north of it we have a miniature copy of it in the Dingle (not in the same line), and one-third of a mile to the west of the latter, another little channel or valley, a shallow one; the two last mentioned cut across a low ridge. And again, one mile west of the Scalp, is what we may call the Gap of Ballybetagh, close to Ballybetagh House. These four gaps or channels are all parallel to each other, and, be it observed, their floors are at very different elevations, that of the Dingle being about 380 feet above the sea; that of the Scalp, 502 feet;

and that of Ballybetagh Gap, about 650 feet. It seems as if no explanation can be applied to the Scalp which does not include the cases of the other evidently related gaps. They can all be with equal ease accounted for by glacial action, and under this view their difference of elevation presents no difficulty whatever. The Glen of the Downs might be mentioned in this connexion, and perhaps even certain ravines beyond it, parallel to striations in their vicinity; but the farther we go in that direction the greater is the need of caution, and it will be safer to stop.

We must not omit to notice what some will regard (but, it is respectfully submitted, without sufficient reason) as a disproof of the denuding power of the ice. It has evidently sometimes flowed, as certain modern glaciers do, over the detrital matter beneath it. This is shown by the often magnificent grinding occurring on the upper surfaces of *large* boulders buried in the drift; this grinding is in one direction, and parallel to that on the rock *in situ;* this might have been seen at the Stillorgan and Vartry valley reservoirs, and may yet be seen in an old gravel pit in Foxrock. But if the ice at one time and place flowed over such blocks and their enveloping detritus without disturbing them, it had previously, when perhaps more actively working, brought them thither from elsewhere, so that its power of denudation remains unassailable.

With reference to the transportation of blocks, Mr. Jukes informs us ("Manual," p. 678), that "the Leinster granite sends off boulders in all directions, except the north, but chiefly towards the south-east." Surely this is because the local ice system of the mountains was, to a great extent, interfered with and overborne by the general glacial movement from the north-westward.

APPENDIX.

Although the striation on the summits of Dunran Hill, 1122 (*see map,* D), and Carrick Hill, 1252 feet (C), may not belong to our subject, it is well to mention it. The normal direction of the striations for both hills shows that the grinding has been *from* west by north, *i. e.*, from the mountains. This is quite clear on Dunran Hill, and still more so on Carrick, where the quartz rock ridges have been rounded on one side, precisely like those on Bray Head. The striations on the south-westerly side of Dunran Hill run obliquely *down-hill;* they therefore cannot have been produced by floating ice. Moreover, floating ice could not have ground those summits in the direction of the striations. Did it float across the mountain range, or through the lowest available gap? It must have passed some hundreds of feet above the tops of the two hills. Did it float from the mountains themselves, on a current flowing *steadily* away at right angles to the partly submerged but continuous ridge? This would be, apparently, impossible. The striations were evidently not effected by the proper ice covering of those two hills, as they have no relation to the slopes. Nothing remains but that they were produced either by the general glacier crossing the mountain range, or by the ice of the local glacial system of the mountains. If the latter alternative be selected, that local system must have been of enormous development; those hills being of the heights mentioned, and both situated at least ten miles from the mountain crest, whose mean elevation is not more than 2100 feet, though it rises much higher in different places.

XIX.—Notes on the Occurrence of a well-marked Specimen of Knorria in the Lower Carboniferous Limestone Series of Kildare. By J. B. Doyle.

[Read before the Royal Geological Society of Ireland, March 8, 1864.]

The fossil plant which I have thought worthy of being submitted to the inspection of the Geological Society was found by a quarryman while engaged in working the Limestone quarry in the townland of Kilreaney, in the barony of Carberry, and county of Kildare. He gave it to his master, Mr. Robinson, of Kilreaney House, who supposed that it was a fish, and as such showed it to his friends as a great curiosity. Mr. Robinson gave it to a gentleman who was engaged in making the survey of Colonel Rich's estate, of which Kilreaney forms a part, and he gave it to me.

I recognised it at once as belonging to a very well-known type, notwithstanding the peculiarity of its shape (to which I take leave to direct your particular attention); and without hesitation I pronounced it to have been found in the Yellow Sandstone of Sir Richard Griffith, as being of such frequent occurrence in that formation.

My friend assured me that I was mistaken, as it was found in Limestone. Having expressed my doubts, he produced a second fossil—the *Cyprina Egertoni*—as having been found in the same quarry by the same man, along with many other smaller shells, "like petrified cockles," as he expressed it, which no doubt were Spirifers, Terebratulæ, Productæ, &c., usually found in this formation.

This led me to inspect the fossil plant with more care, and I soon satisfied myself, both by inspection and by the application of muriatic acid, that its mass was composed of bluish-grey Limestone. I also observed on one side a small piece of crystallized carbonate of lime, which any person may see by holding the specimen at a proper angle.

Never having met with the like before in my limited sphere of observation, and greatly distrusting my palæontological skill, I showed the fossil to several members of the Society, and also to Sir Richard Griffith, to whom I made known the amount of evidence I had obtained of the locality, and of the circumstances connected with its finding. This evidence I now take leave to submit to the Society.

Fearing that there might be some mistake about the matter, I took the precaution to write to Mr. Robinson, the proprietor of the farm upon which the quarry is situated, and at the same time I sent him a map, upon which I had coloured the townland of Kilreaney, requesting him to mark with a cross the precise situation of the quarry in which the fossil had been found. In reply to that note, I received the following letter:—

" *Kilreaney, January* 22, 1864.

" **Dear Sir**,—I have received your letter, and in reply I have to state that there is on the townland of Kilreaney a limestone hill, called Ballycane, where we quarry stones for the purpose of burning lime, and where some of those fossils are occasionally met with. Not understanding their nature, we set no value on them whatever. Should you again visit our neighbourhood, I would be most happy to point out to you the place, and give you every assistance to procure some specimens of those fossils, or any other information you may require.

" I am, dear Sir, your obedient Servant,

" *J. B. Doyle, Esq.*" " Edward Robinson.

This letter, from one who had not the most remote idea of the object I had in view, will I am persuaded settle the question of the finding and of the locality, to the satisfaction of the meeting. Having, as I have said before, submitted this letter, and map, and fossils to Sir Richard Griffith, I am permitted to refer to his field map, upon which he has laid down the Limestone formations in the townland of Kilreaney; from which it will be seen that the Lower Limestone occupies the smaller or northern division of the townland, and the Middle Limestone the southern or larger division—the former stone being of a bluish-grey colour, and the latter consisting of black flag and beds of shale—the Lower Limestone dipping under the Calp, or Middle Limestone, at an angle of 20° a little to the west of south, the latter showing a dip of 20° to the south-east.

It will also be seen that the quarry in the Lower Limestone lies in a sort of anticlinal, between beds dipping to the north at 10° to the north-east, while those of the south of the quarry dip 20° to the west of south.

That such a strongly marked fossil, of such a well-known type, should be found in the middle of the Carboniferous series, and in the immediate proximity to a superior formation, is in the opinion of Sir Richard Griffith a fact worthy of being recorded; and it is a source of pleasure to me to find my own conjecture confirmed by such a high authority.

I think it right also to mention, by permission, that Sir Richard informed me that he found in the Lower Limestone, in the north of the county of Dublin, a well-marked specimen of a Calamite; from which, and from the circumstances now under our notice, we may reasonably hope that fresh discoveries in this direction may be expected from our field geologists.

I may also observe that the relative situations of the Lower and Middle Limestones of this district, as laid down on the maps of the Geological Survey, very nearly if not entirely correspond to Sir Richard

Griffith's maps, and in both the situation of the quarry is in the Lower Limestone.

I have now submitted the fossil and the history of its finding to the scrutiny of the Society, and, should the specimen be deemed worthy of acceptance, I shall have great pleasure in presenting it, along with the map marked by Mr. Robinson, and his explanatory letter.

In conclusion, I may observe that the fossil plant is of the genus, *Knorria*, the species probably being *imbricata*. It is remarkable for the state of preservation in which it has occurred; and I believe I may add that this well-known species, found as I have described, carries us higher, or rather into more unusual habitats than we are in the habit of contemplating.

XX.—ON A NEW LOCALITY OF GRANITE IN LIMESTONE NEAR RATHFARNHAM.

By HENRY B. S. MONTGOMERY.

[Read before the Royal Geological Society of Ireland, March 9, 1864.]

ON the north bank of the River Dodder, opposite Rathfarnham Castle, the seat of the Lord Justice of Appeal, there is situated a small quarry, belonging to Mr. Calville, of Rathgar. It is so placed that it is not visible from the road, which runs along the south bank of the river; but any person going along this road may notice a limekiln on the opposite side, placed just on the edge of the quarry. The best mode of access to the quarry is through the Rathgar Sawmills.

On examining it, although it is upwards of a mile from any granite *in situ*, numerous lumps of granite imbedded in the limestone are to be met with.

These I observed some months since; and one evening afterwards, in company with Dr. Haughton, I visited this quarry; but we were unable to find the granite in more than *one* bed. However, since this, with Mr. Ormsby, on an extended examination of the position of the beds, we found the granite in two separate strata, with two beds between them.

This corresponds with what is found at Crumlin, the only difference being that there there are twenty beds intervening between those containing the granite, while here, as was mentioned before, there exist but two.

The beds in this quarry vary greatly in thickness; and to illustrate this, as well as to point out those containing the granite, there are placed on the wall three sections of the quarry, drawn to a scale of an inch to the foot,—the only inaccuracy is, that the fragments of granite there represented are sketched from memory, the rest being drawn from actual measurements.

It is worthy of remark, that the granite always occurs in clusters, so that when you find one specimen you may be sure that there are more in the neighbourhood.

Seeing many specimens of the granite quite soft, I inquired of the workmen whether this was the usual state in which they occurred. They informed me that they are quite hard when first extracted, but that on exposure to the atmosphere, and specially to water, "they," as they expressed it, "slaked like lime."

I then tried many of the specimens with hydrochloric acid, and in every case got abundant effervescence,—proving that the granite is saturated with carbonic acid, or contains carbonate of lime.

Looking at the specimens *in situ*, a very remarkable appearance is to be observed; for though they are both angular and rounded, yet they all lie with their heavier ends downwards; and this at once suggests to the mind the idea that they have dropped through water of such a depth as to allow them to assume their natural position, and finally to become imbedded in the mud beneath.

XXI.—On a remarkable Specimen of Ulodendron, found at Hurlet, Renfrewshire. By Alexander Macalister.

[Read before the Royal Geological Society of Ireland, May 11, 1864.]

The subject of Fossil Botany is one which must naturally be involved in very great obscurity, partly from the perishable nature of many of the most important portions of the vegetable organisms, and also from the fragmentary character of the remains on which all our deductions are founded. On this latter account palæontologists are liable to figure and describe different parts of the same plant not only as different species, but even as distinct genera, where they are found dissociated; and it is only when by chance a specimen is thrown in our way showing the connexion of these various parts, that we can ascertain precisely the relation that they bear to each other. Thus it is extremely probable that we shall shortly be able to reduce the reputed number of fossil plants by finding many of the so-called genera to be but the *membra disjecta* of a single species; and thus the specimen before us is interesting, as presenting appearances which, if found unconnected, might easily, have been referred to distinct generic types.

In 1862, while engaged in examining some portions of the Renfrewshire Coal-field in the district of the Hurlet, about three miles south-east of Paisley, I obtained this specimen, along with some fragments of Sigillaria, Calamites, and other fossil plants. The district is one of extreme geological interest, celebrated for its alum works and for its iron mines. The bands of ironstone are separated from each other by black slaty beds, in which the fossil plants are occasionally found. The miner from whom I obtained this specimen described it as a fossil fish, and stated that such specimens as it is were by no means frequently found. On examination, I recognised it as the *Lepidodendron ornatissimum* of Sternberg by its peculiar scars, but was much puzzled by the other portions of its surface. My specimen measures eleven inches in length, and

$5\frac{1}{4}$ in breadth, and exhibits along its border six of the characteristic circular scars which at once distinguish this plant, now erected into a genus under the name Ulodendron. Of this genus Lindley and Hutton describe two species; the first, or *Ulodendron majus*, is characterized by its larger size, and by its scales being wider transversely than vertically; the second, or *U. minus*, is known by its smaller scales and scars, the former being elongated in their vertical axis. The present plant resembles the latter in its size, and in exhibiting at its upper and left border the vertically prolonged scales; but in the central portion these markings are of the transversely enlarged character of *Ulodendron majus*. The specimen is curved along its margins, and widens towards its upper extremity, where at first it exhibited somewhat of a dichotomous mode of division. Unfortunately, however, in the carriage one corner became chipped and broken off, so as to mar the distinctness of this interesting appearance. Its surface is marked by four or five longitudinal folds, as indeed is apparent in most of the figured specimens; but the principal point of interest exhibited by it is, that we have here exposed two different surfaces of the thin, carbonaceous, cortical lamella. We have the cast of the external surface shown, where the cortex has been chipped off, and besides, we have what must be considered the inner surface of the cortical lamina, marked by a number of elevated points. This surface has been described in some Sigillariæ; but, though represented in a corner of the plate of Brongniart, it is undescribed by him in Ulodendron. On this surface we observe a series of small elongated elevations, or points, which are arranged in an alternate manner, forty-eight to the square inch, each row being separated by a shallow, almost obsolete groove. They are about $\frac{1}{10}$th of an inch in length, and $\frac{1}{24}$th in breadth and each when examined presents a small depression, with an elevated angle above, being rather more sloping below. Most probably these represent the extremities of the woody bundles permeating the cortical lamina, and they generally correspond, though not accurately, to the scales of the external surface.

The scars represented in my specimen are six in number; each measures thirteen lines in diameter, and presents in the centre a small circular prominence. Over the whole of these circles can be traced obscure markings as those of the woody fibres. When the cortical lamina is removed from one of these circular discs, the cast exhibits some peculiar wrinkles or foldings, principally longitudinal, with a few ramifying transverse lines. Of the nature of these markings we know little, but they have been conjectured by Lindley and Hutton to be the impressions of the bases of cones. If so, M. Brongniart observes they should be rather more concave than they appear to be, either in my specimen or Brongniart's figure. They have been also said to have been the stem-leaves, crushed by the pressure of the cones of fructification; or we might imagine them to be the scars of gigantic leaves arranged in a distichous manner, as is supposed by Lindley and Hutton to be the case in *Megaphytum*. In the ninth volume of the "Transactions of the Royal Society of Edinburgh," Mr. Allan, in describing the specimen of this plant found at Dalkeith, suggests that they might be scars left by the branches of a Cactaceous plant; but I have examined, with my friend Dr. Moore, all the Cacti at the Glasnevin Gardens, and have not as yet been able to detect anything bearing the slightest resemblance to this arrangement. If I might be permitted to hazard a conjecture on this difficult point, I should say that among modern plants Ulodendron ranked nearer the Cycadaceæ than any other Order. This idea struck me on comparing the order of arrangement of the leaves and scars of several of the modern species of this Order with the present fossil. In *Encephalartos pungens* there is something like a similar arrangement, differing however in this, that the scales are well nigh as numerous as the scars. A greater similarity, perhaps, may be traced to the *Macrozamia Denisonii*, an Australian plant, discovered by Mr. Charles Moore, of the Sydney Botanic Gardens. Had we a Cycadaceous plant whose leaf scars were large and circular, and whose scales were as numerous and small as those of a Lycopod, we could realize all the conditions of Ulodendron. The apparent dichotomous division at the upper part of the slab is no objection to its probable Cycadaceous nature, as I have seen that disposition in at least one plant of that Order.

In conclusion, I would wish to point out the probable identity of *Ulodendron majus* and *minus*, as the variation in shape and size is scarcely sufficient to constitute a specific distinction.

XXII.—On a Recent Erratic Block. By F. J. Foot, Geological Survey of Ireland.

[Read before the Royal Geological Society of Ireland, November 9, 1864.]

The glacial question is one of so much interest to geologists, that it is important to record every well-ascertained fact connected with the mechanical action of ice.

At the present day, in the British Isles we have no glaciers, and the sea seldom freezes around our temperate shores. Glacial action, once so powerful, and so widely extended, is almost exclusively confined to the degradation of cliffs, large fragments of rock being detached, and caused to fall in winter by the freezing, and consequent expansion of water which finds its way into the open joints and crevices in the rock. Even limited to this, ice is no mean agent in altering the configuration of a country during the lapse of ages, and in supplying detritus, to be strewn eventually over the bed of the sea, and, in time to come, perhaps to be raised above its surface in the form of new land.

But I have had lately brought to my notice an instance showing that ice can occasionally do more than this; that, instead of being solely a stationary engine, it may also act as a locomotive one; and that, under favourable conditions, large blocks may still be transported by it.

At the northern extremity of Lough Ree, on the Shannon, on the Longford side, the water of the lake is very shallow for a considerable distance from the shore—too shallow, indeed, in most places to float a small boat. Here and there, crags of limestone extend for some distance along the shore, but the bed of the lake itself is composed of shingle and large and small fragments of limestone.

On the shore at Rathcline, the residence of St. George Johnston, Esq., a little shingly promontory, scantily covered with grass, juts out into the shallow water of the lake; and at a distance of twenty or thirty yards from its point may be seen, resting against each other, two dark coloured, rugged, waterworn blocks of limestone.

When I visited the spot, on the 17th of October, the depth of the water appeared to be about two feet. The dimensions of the mass, as roughly estimated, are about seven feet in length, three feet in breadth, and three feet in height from the water line. The weight is probably about two tons. These blocks are *recent erratics.*

Before the great frost, which commenced in January, 1855, memorable to naturalists and sportsmen as having been so destructive to our birds, there stood out in the lake a conspicuous rock, or boulder of limestone, fifty yards west of the present site of these two blocks.

Mr. Johnston, to whom I am indebted for information on the subject, tells me that, when visiting Quaker's Island—a valuable island belonging to him, about four miles to the southward—he always steered by that rock, so that it was well known to him and his boatman. At high water, after floods, it was sometimes covered, and was then dangerous to boats. When the frost commenced, the water of the lake was very low, the depth being three feet or so at the rock, which protruded about 2½ feet above the water.

The frost lasted six weeks; at the end of which time a thaw set in, with a strong south-west wind. The ice broke up, and immense blocks of it were piled up on the Rathcline shore; the breaking up and piling of these huge masses of ice was accompanied by a roaring sound, which could be heard at a considerable distance.

As well as I can ascertain, while the storm increased, the wind went more to the west. During the thaw the water of the lake rose about two feet by means of the fresh flood-water and the force of the wind. Then this block of limestone was actually floated up from the bottom by the great mass of ice into which it was frozen, and drifted in before the wind till it grounded in shallow water, and smashed in two in its present position off the point of Rathcline. The first time after the thaw that Mr. Johnston went out boating, he and his man were struck by the altered position of the rock, and on coming up to it they observed that it was broken in two and turned upside down.

Mr. Johnston, in writing to me on the subject, says—"My opinion at the time was, that the stone—a very rough and jagged one—had gradually become entirely frozen up and united with the ice; that as the Shannon rose the stone was raised up with it, and in the ice, which was then driven into the shallow water and turned up by the storm. . . . . In its original position the stone lay in the way of a small boat hugging the shore, when the wind blew from the east, and it was desirable to keep close to the shore; this caused me, the very first time I was on the Shannon after the frost, to remark the change of position in the stone, and then on coming nearer to it we thought it had been turned upside down."

Singularly enough, a little more than half a mile north-east of the blocks on the hill between the lake and Rathcline House, there is also a good example of an erratic of the glacial period; it is a remarkable boulder, perhaps a ton in weight, very hard and siliceous, and bright red; in fact, it is jasper. Now, jasper is seldom found *in situ* except in the form of pebbles in the Old Red Conglomerate, and I have often wondered whence they were derived.

North-east of Rathcline, in the county of Roscommon, the long ridge-like hill of Slievebawn rises from the generally level limestone plain to a height of 850 feet above the sea, exposing the sandstones and conglomerate of the Old Red and the subjacent grits and shales of the Silurian. In the latter rocks, and near the summit of the hill there occurs, apparently in the form of a large vein, a mass of hard, blood-red, very siliceous rock, which I can only designate as "*jasper rock.*" It is a great, rugged, amorphous mass, homogeneous in texture, and presenting to the view no lines of stratification. No actual junction is seen between it and the adjacent Silurian grits and shales, but it is most probably a large vein or pocket.

Being well acquainted with this rock, I at once recognised the Rathcline boulder as a fragment of it, and there can be no doubt that it is an erratic from Slievebawn. The distance from the boulder to the parent rock is just six miles, and the direction N. 30 W.

Thus we have, side by side, these two erratics: the one of jasper, carried by an iceberg a distance of six miles countless ages ago, in the far off glacial period; the other of limestone, transported fifty yards by a mass of fresh water ice, ten years ago.

APPENDIX.

" *Longford, November* 8, 1864.

"MY DEAR SIR—When out surveying to-day, I came across a surface of limestone, about twelve feet by fifteen, or so, laid bare of soil, and most beautifully scored by (glacial?) striæ, perfectly parallel, some of them nearly an inch deep, and bearing N. 25 W. nearly. Now, if any one take a glance at the inch maps of this district (the plain ones) they will at once be struck by the wonderfully parallel conformation of the country with respect to streams, low hills, and long narrow bogs. The direction of this parallel conformation is generally about from N. 20 to N. 30 W., coinciding with that of (glacial) striæ above-mentioned; also the direction in which the jasper boulder, mentioned in my paper, is carried, is identical, or nearly so, with it. Would you be kind enough to mention this fact when my paper is read, as I think it is very interesting.

" Yours faithfully,

"F. J. FOOT."

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CONTENTS OF No. XVIII.—APRIL, 1865.

WITH ONE PLATE.

PAGE

1. On an Abnormal Morphological Developement of the Common Snowberry. By ALEXANDER MACALISTER, M. D., ... 97
2. Description of a New Species of Docidium (Bréb.), from Hong-Kong. By WILLIAM ARCHER, ... 98
3. Account of Ogham Inscriptions in the Cave at Rathcroghan, Co. Roscommon. By SAMUEL FERGUSON, Q. C., ... 99
4. Report on the Progress made in collecting the Irish Lichens, accompanying a Presentation to the Natural History Society of a complete Series of Specimens of those hitherto collected; with an annotated List thereof, alphabetically arranged, and an Index-List to the Collection in the order in which the Species occur therein. By Admiral THEOBALD JONES, F. L. S., F. G. S., ... 100
5. On Flax, and the Practicability of Extending its Cultivation in Ireland; together with Directions for the Proper Management of that Crop. By EDMUND W. DAVY, M. B., M. R. I. A., &c., Professor of Agriculture and Agricultural Chemistry to the Royal Dublin Society, . . 144
6. Some Hints on the Successful Reclamation of Bog. By GEORGE ELLIS, M. B., ... 171
7. Notes on the General Glaciation of the Rocks in the Neighbourhood of Dublin. By the Rev. MAXWELL H. CLOSE, ... 177
8. Notes on the Occurrence of a well-marked Specimen of Knorria in the Lower Carboniferous Limestone Series of Kildare. By J. B. DOYLE, 187
9. On a New Locality of Granite in Limestone near Rathfarnham. By HENRY B. S. MONTGOMERY, ... 189
10. On a remarkable Specimen of Ulodendron, found at Hurlet, Renfrewshire. By ALEXANDER MACALISTER, ... 190
11. On a recent Erratic Block. By F. J. FOOT, Geological Survey of Ireland, ... 192

Dublin: Printed at the University Press, by M. H. Gill.

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QUARTERLY JOURNAL
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SCIENCE:

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THE ROYAL DUBLIN SOCIETY; THE ROYAL IRISH ACADEMY;
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Edited by
THE REV. SAMUEL HAUGHTON, M.D., F.R.S.,
FELLOW OF TRINITY COLLEGE,
AND PROFESSOR OF GEOLOGY IN THE UNIVERSITY OF DUBLIN.

Ὁ βίος βραχὺς· ἡ δὲ τέχνη μακρή· ὁ δὲ καίρος ὀξὺς· ἡ δὲ πεῖρα σφαλερή· ἡ δὲ κρίσις χαλεπή·—HIPPOCRATES.

N° XIX.
JULY, 1865.

WILLIAMS AND NORGATE,
14, HENRIETTA-STREET, COVENT GARDEN, LONDON;
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XXIII.—Notes on the Physical Features of the County of Donegal. By W. Harte, C. E.

(Plate VI.)

[Read before the Royal Geological Society of Ireland, June 9, 1864.]

The mineralogy of the county of Donegal having already received so much consideration in the proceedings of this, the London Geological Society, and the British Association, it may be interesting to lay before you the result of some investigations of mine into its physical features, which are not alone striking from the boldness of their scenery, but from the fact that they have received, as I think I can show, much of their present forms from the last great epoch in the history of our planet, that of the glacial period.

The county is intersected by bays, estuaries, and river courses, flanked by the higher mountain ranges and hills; and so much is it thus cut up, that no portion of it is twelve miles from the reach of the tide.

The peat and vegetable soils rest upon the drift, and these again directly upon the Primary, Metamorphic, and Palæozoic rocks. The latter consist almost exclusively of the Carboniferous system, and are only found fringing the Bay of Donegal and near Pettigo, Muff, and Carrowkeel.

The higher and most central mountain range runs from the southern end of the county to the north, in a general direction almost due north. It there is met by the range which runs along the north end of the county to the north of east, including the mountains of Errigle (2462 feet high), Dooish, Muckish, Slieve Snaght, &c., and parallel to the direction of, and through the district where the trap rocks attain their greatest developement. The main igneous feature of the first range is the granite, while that of the second is the syenite.

To the east and west of this dividing granite range, or main axis of elevation, run several valleys; those of the Rivers Eske, Eany, Glenties, Gweebarra, and Gweedore on the west; and those of the Mourne, Finn, Swilly, Lennan, &c., to the east and north.

Towards the southern end of this range, near the head of the Bay of Donegal, we have a group of mountains, which have been termed the "Central Granite Patch," which I shall describe more particularly, as it is a district of much interest. Through this group of mountains runs the present road from Sligo to Londonderry, through what is called the "Gap of Barnesmore," which is the only gap in the range.

To the south of the road lies the steep escarpment of Barnesmore Mountain, which rises to a height of 1491 feet; and to it immediately succeeds the range of crystalline schists and gneiss, which, including Breecy Mountain, sweep round the south coast of the Bay of Donegal, and terminate at Lough Erne, near Ballyshannon.

To the north of the road in the "Gap," rises the rounded form of Croaghconnellagh (or Townawilly) Mountain, 1724 feet high. The valley of the Gap runs round the north east end of this mountain, and then west again, parallel to its first course, dividing Croagh Connellagh from the next ridge, Croaghanirwore, 1972 feet high, and it is there closed by the col of greenstone, &c., which separates it from the Eske valley. To this valley of the Barnes River, as possessing some interest, I shall have to refer again. To this latter ridge succeeds another valley; and on the other side the last of the granite rises with a steep escarpment over Lough Belshade, facing the south. This mountain is called Croaghgorm, or the Blue Stack Mountain, and is by far the boldest and most rugged of the granite mountains of Donegal, rising to a height of 2219 feet. Lough Belshade lies in the gneiss at the foot of it; and the north side of this mountain and the south side of Barnesmore both have long slopes, exhibiting thus the structure of "crag and tail."

Then succeeds the northern range of Primary and Metamorphic rocks, schists, and quartz, which flank the northern side of the bay, ending in the splendid cliffs of Slieve League, 1964 feet high, and form the western headland of the bay.

Radiating from this central granite to the north-east, and south-east, are the valleys of the Rivers Finn and Mourne, and of the Inver and Eske Rivers to the west and south-west.

Within this basin of the Primary and Metamorphic rocks surrounding the Bay of Donegal, and lying all round between them and the sea (except towards the north-western extremity of the bay), the country consists of the Old Red Sandstone and Carboniferous formations.

This Barnesmore granite, as I shall call it (while, however, it is to be understood as a name for that of the whole central granite), is a very hard compact granite, of a pink-grey colour, and contains crystals of a deeper red orthose scattered through it; and so uniform are its characters, and distinct from the other granites of the county, that there can be no difficulty in recognising it whenever it is met with.

Passing from Blue Stack along the col which divides the valleys of the Eske and Inver Rivers, we come almost at once upon the Old Red Conglomerate. A thin chocolate-coloured band with white quartz pebbles, of equally striking appearance with the Barnesmore rock, and constantly accompanying it, they form unerring guides to the western drift, whether found in the shape of large blocks, or of fine gravel.

We next come upon the Lower Limestone and coarse conglomerate of the Yellow Sandstone (a very different one from the last, being all quartz pebbles and sand), and which is succeeded by the finer beds of sandstone, in which the Mountcharles quarries lie. This ridge divides the valleys of the Eske and Eany Rivers and estuaries; and along the course of both, running out to the sea from the high granite range, the lower soft sandstone and arenaceous limestone rocks are cut up by valleys bearing south-west, and these are again intersected by other valleys obliquely crossing them, forming hills varying from about 50 to 500 feet high.

Far in all directions along the courses of the river valleys of the Eany, Eske, Finn, and Mourne, radiating from this centre into the county of Tyrone, and out to sea, may the drift from these mountains be traced (the conglomerate, so far as I know, only appearing to the west). It lies on all the hill-tops, and forms much of the subsoil of the valleys. It is characterized, as usual, by the large "erratics," and the smaller boulders and gravel. The former for the most part are rather wanting in angularity, having been subjected to the rubbing action of the latter when the sea was falling; nor are many of these erratics very large (though they are to be met with up to forty tons in weight); for the granite of Donegal, as so well described by our late President, Professor Haughton, "possesses a stratified structure in beds which are nearly vertical;" and "in addition to this stratified, or cleaved structure, it is traversed by many joints, which run nearly at right angles to the directions of the planes of the cleavage structure,"—characters more applicable to the Barnesmore granite than perhaps to any other in the county, as some of the soundest blocks, apparently, cleave only to a size of eight inches cubic when being dressed, while it accounts for the comparatively small size of the boulders and erratics generally, and which it is well to keep in mind when estimating the effect of a glacial climate, and the facility which these rocks afford for excessive denudation. The erratics, however, from Blue Stack Mountain, which I have described as being of more massive structure, were chiefly carried down the Finn Valley, and attain to very large dimensions.

The Yellow Sandstone ridge upon which Mountcharles stands is the highest of the hills within the basin of those Primary rocks, and consists at Lough Eske of the coarse-grained conglomerate of sand and rounded quartz pebbles only.* This ridge terminates abruptly in a bluff at the shore of Lough Eske, near the col which separates the valleys of the Eske and Inver; and on the terraces of its face, formed by the out-cropping of the lower limestone beds, the granite boulders have been dropped. It there rises to a height of 1275 feet, upon which rest blocks of the granite from Blue Stack; and as it rose from the water at an early part of the glacial period, it subdivided the currents of larger ice, which then first scooped out these valleys of the Eske and Eany. Within these valleys, as I have said, are a number of smaller hills. Their shape is of an ovate form, except where modified by local circumstances, the bluff end, or higher slope, being turned towards the mountain range, and the longer slope towards the sea. The direction of the major axes of these hills converges, and exactly follows the course which the ice, when breaking up, would have to take in falling away from the inner sides of the basin of the mountain range, towards the sea; and with singular accuracy do we find the drift deposited upon these hills and in those minor valleys to consist of the Primary rocks, whether granite, schist, or gneiss, to which the longer axis of each hill points: thus we have near Donegal the granite and conglomerate on those pointing to Barnesmore, while we meet chiefly garnetiferous schists of Finmore at Laghey, and the gneiss of the Aught Mountain at Ballintra, &c.

---

* It may be interesting to those who insist upon a geological distribution of certain plants to say, *en passant*, that in the crevices of these huge rocks, dislocated by the action of ice, I found the *Hymenophyllum Tunbridgense* in flourishing growth in March last at the height of 1275 feet, where not four feet from its habitat hardly any vegetation exists.

Those hills of the Yellow Sandstone and Lower Limestone are smoothed and dressed by the action of the sea, which washed down the smaller drift towards their bases, and mixed it with the local lime and sandstones, and doubtless this was caused by the floating out to sea of the smaller ice, an ample store of which would be provided when the land rose so as to form a large fiord where Lough Eske now lies.

The rocks forming these hills dip at an angle of about 20° from the granite towards the sea, to which cause I attribute the absence of polished and striated surfaces, as the rubbing action of the ice would be against the ends of the beds, and not against their upper surfaces.

I observed that I would allude again to the " Gap of Barnesmore." It rises at its east end against the col which separates that valley from those of the Finn and Mourne; and being a branch of the Eske valley, it turns, as I described, to the north, and then back, westward, round Croaghconnellagh, giving to the latter its hemispherical appearance. The valley is very narrow at the level of the road, being only about 150 or 200 feet wide at the base of the mountains, which, as I said, on the south, or Barnesmore side, form a steep escarpment, while on the north side it slopes at about $\frac{1}{2}$ to 1; altogether, the steep valley may be said to be about four miles long.

Both the road and river in running through the Gap cut through ridges of *debris*, in fact *moraines*, the terminal ones of an ancient glacier (marking successive stages of its retreat, very probably), and which at one time filled this valley, and left a large deposit upon the col between the head of the Gap and the valley to the east. It is hard, in granite so fissile and so easily weathered, to find marks of erosion, but these are not altogether wanting; grooving and terracing can be detected at considerable heights by close observation. In the same way the other valleys which occur throughout the range to the north of this must have been filled with glaciers also.

So much for the disposal of the ice on the interior of the basin of the Bay of Donegal. On the outside of this range, and along the central dividing ridge, the ice must take a course the reverse of a convergent one, and diverge, breaking up into sections determined by the directions of the spurs of the main range, and it accordingly did so.

That lying to the north of this central range and west of the northern chain went to the north-westward, while that upon the high mountains near Fintown descended, and, joining that from the valley north of Blue Stack, scooped out the valley of the Finn, which became ultimately joined by the ice from the southern end of the range, after passing along the course of the Mourne, and formed the valley of the Foyle. To the north of this "central granite" the ice simply broke away to either side, east and west, forming the long straight valleys of the Gweebarra, Glenveigh, &c.

The original disturbing igneous force which upheaved those mountains operated with its greatest intensity upon the central granite, giving the radial structure to it, and throwing out spurs as it passed northward, which, as I have said, fixed the subsequent course of the ice; for I do not find the rocks of any of its divisions to have crossed the intervening ridges, but simply followed the course of the retreating ocean.

As I have described, between the granite range and the coast of the Bay of Donegal, the country is what may be called a rapidly undulating one, and these undulations come down to the edge of the shore. Let us now go a little further, and we find by the naval charts surveyed by Captain Bedford, R. N., in 1853 (and they afford ample details), that no such undulations exist in the sea bed off this coast. Those hills of from 50 feet to 500 feet high which I have been describing, and whose seaward ends are abraded by the action of the sea, cease at once at the shore, and in their place succeeds an almost level sea bed; and if we refer to the more extended surveys, we find the same plateau or gentle gradient extending to the edge of the 98-fathom contour, or so-called "Irish bank," nearly 60 miles off the coast, unbroken by a single sounding, that if the sea bed were dry would prominently attract the eye as an inequality, showing no sign of glacial disturbance, and which the slight elevation of seven feet per mile would be sufficient to bring above the level of the sea. (See Plate VI.)

I think it is a fair inference from this that, though the land rose (where we now find the erratics) at least 1300 feet above the level of the sea (and very likely went a little further), the glacial action was then at its close.

I may now call attention to another feature of some importance, that of the bogs of the county. They lie on flats, at all heights, from the mountain tops to the level of the sea. In them the remains of ancient forests are embedded, at least from the 500-feet contour down. Above this level and up to the 1200-feet contour, I have found only a few straggling remains of dwarf trees in the peat—the roots standing as they grew in the peat and on the surface of the drift and Pleistocene gravel. Many of those forests are submerged at high water, and at a few feet higher level than high water are several others. Much stress has been laid upon these submerged bogs, as showing, it has been supposed, oscillations in the relative levels of the land and sea since the glacial period. I have examined numbers of these submerged bogs; and though I am still engaged in doing so, up to this I have not found any satisfactory evidence to show that this submergence is due to alteration of the level of the land since the drift has been deposited. All the cases I have seen are quite consistent with either of two views—one, that these submerged bogs and forests in some cases were detached, probably by fresh water, from those at higher levels, and deposited below or at the edge of low water. The other view is, that they were originally growing in lagoons, and that the erosion of the coast eventually brought them within the action of the sea. In nearly all the cases I have seen, the latter seems the most usual; and while we cannot say anything of those forests that may be under the sea (and they probably are very extensive), we can say, so far as my experience goes, that those just above high water show indications of never having been submerged; and this could not be if those oscillations of level had occurred, which are described to have taken place in some geological works.

One case forcibly illustrating this view I may state more in detail. While staying at Dawross, a bay about six miles north of the village of Ardara, a friend of mine mentioned his surprise at having lately become possessor of some excellent bog upon the beach, over which he had hauled up his boats for years, quite unconscious of the existence of any forest being several feet under it. I examined the place, and there found the roots of trees (oak and fir) lying in peat, the bottom of which is from twelve to fourteen feet below the level of high water; and on investigating the whole circumstances of the case, I found, beyond all manner of doubt, the following to be the true explanation of what would *primâ facie* be set down as the results of depression of the coast, and subsequent upheaval.

The whole coast is of mica slate, impregnated with andalusite, and the rocks are very easily broken up, being traversed by very close planes of cleavage, so that the work of encroachment by the sea goes on with the greatest rapidity at times. There are numerous small islands out to sea and across the bay, three of which were connected in the memory of those living there, forming a little promontory—that is, there was between, in front, and behind them, and joining them with the shore, a beach composed of large and small stones (the *debris* of the same rocks) mixed with sand, and over that four to six feet of "blown sand," upon which was grass and bent. It was under this beach that the bog lay. Outside these little islands are other rocky islands, forming a breakwater.

Originally these trees were growing in a lagoon, in which these islands formed projecting rocks. When the sea made its present passage through the outside barrier (now island), which it would do as it has just done suddenly, it swept in the beach lying outside through the breaches it had made, and buried the trees and bog inside under the shingle and the *debris* of the rocks. Over this came the "blown sand," and on it grew the bent, the outside rocks through which it forced its way acting as a breakwater to this new formation. The bog and trees lay thus buried, probably for ages; but now, within the last two years, the breakwater being too much eroded to form a sufficient protection any longer, the sea is now undoing—indeed, has almost completely undone—its own former work, and is breaking up the bog and the islands (lately a promontory), and in a very short time all will be away, with much of the inner shore.

Thus we have a bog buried, probably a great length of time, under a beach, according to popular ideas, rising into view again, withont the slightest room for doubt, on a close examination, that, so far as evidence goes, it never changed a foot in level since the time when it stood, as unquestionably it did stand not long ago, geologically speaking, about two miles inland, and very probably was protected, when these three were growing, by some of those greenstone dykes which run parallel to the coast line.

I do not wish to be understood as taking upon myself to deny a secular depression of the coast; I only want to show how one of the best cases instanced as leading to such a view tells, on close investigation, as much for the contrary opinion.

As I pointed out, at the close of the glacial epoch the land had risen to about its present level; and there is no reason to say that that upheaval may not have been carried a very little further, with a gradient of less than seven feet per mile, which would have exposed the present sea bed, and left a margin of sixty miles at least of land outside our present west coast line. This would have exercised an influence most favourable to the growth of forests, even at the high levels inland, and to the development of a series of lagoons, upon the inner edge of which we now look, after they have been encroached upon by the sea, while they may be possibly descending again; but, if so, it is for the first time; and such depression of level has not before occurred within the period of the extinct forests, and acts only as an auxiliary to the undoubted erosion of the coast, which has accumulated at the foot of the high lands the immense sand-dunes we see now on the exposed parts of the shore.

I shall not enlarge here upon the subject of the temperature of the glacial epoch. I may state, however, the following:—The highest point of Blue Stack is now 2780 feet below the snow line. If to this we add at least 1300 feet, which it was lower previous to the upheaval at the close of the glacial period, we shall have its summit then 4080 feet below the present snow line! Glacial denudation alone, without a lower snow line, cannot possibly account for all this; and the facts seem to me to be strongly opposed to those who, on the one hand, would dispose by change of temperature alone of the glacial question, irrespective of any upheavals or depressions of the land, or to those who, on the other hand, hold only to the idea of the much greater elevation of the land then,—while they appear to me to harmonize well with the middle view of a combination of both theories, viz.:—greater height of land, and a lower snow line, at the earlier parts of the glacial epoch. This, I know, is a *vexata quæstio;* but my object in laying these Notes before you has not been to theorize upon so important a question, but in the hope that, though of more local perhaps than general interest, they may afford some useful information upon the Post-tertiary geology of Ireland.

XXIV.—ON A POLISHED AND STRIATED SURFACE IN THE LIMESTONE OF ROSS HILL, CO. GALWAY. By M. H. ORMSBY, B. A., L. C. E.

[Read before the Royal Geological Society of Ireland, April 13, 1864.]

ON the Midland Great Western Railway, between Galway and Oranmore, there is a low range of hills, over which the line passes through a shallow rock cutting, as nearly on the surface of the ground as possible, having heavy gradients of 1 in 100 on each side.

At the time that the railway was first formed, good building stone was obtained from this small cutting; and as many works have been for some time since in process of construction at the western end of the line, it was determined to lower the road some eight or ten feet at this point. Thus two ends could be attained—first, a sufficient quantity of stone could be procured; and, secondly, the gradients on each side of the hill could be considerably improved.

The rock here is a hard crystalline limestone, apparently belonging to the Upper Limestone Series. Its average strike is W. 80° S., while the dip varies from about 5° to 20°. The beds differ very much in thickness; they abound in fossils—some of them, indeed, are almost entirely composed of Productidæ.

When the new cutting was first begun, we observed, as soon as the surface clay was removed, that the top of the rock, to a considerable extent, was brightly polished, grooved, and striated in different directions.

The well-known main road from Galway to Oranmore runs to the south of the line at the place where these phenomena occur, and goes under the railroad a short distance further west. Another road runs north, and passes over the line by a level crossing. From a few yards to the west of this crossing, nearly up to a small over foot bridge, connecting the fields on the summit of the hill, the rock is polished in a greater or less degree; but further to the west of this, on towards Galway, no markings of any description are to be found.

In places where the maximum polish may be observed, the rock is covered to depths varying from two or three inches to several feet, by a highly aluminous clay, containing quantities of coarse drift gravel, and numerous large boulders. The gravel is chiefly composed of limestone, small quartzose pebbles, and rolled pieces of serpentine and granite, while nearly all the boulders, as far as we could perceive, appear to be granitic. In these the feldspar was in all cases reddish, as is common in the Galway granites. Above this is the ordinary surface clay, having a depth of from one to seven feet.

In one place, about 300 yards to the north of the railway, we dug a large hole, more than five feet in depth; four feet were through the ordinary soil, and one foot through the clay containing the gravel, while the rock below was very highly polished, and greatly striated.

Further to the north of this we had no means of ascertaining the nature of the underlying rock, as the earth gets deeper as you proceed. In one place, indeed, nearly one-eighth of a mile from this, some months since we got a glimpse of the limestone where some drainage works were being carried on. There the rock was in its ordinary state, no indications whatsoever of a polished or even smoothed surface being perceptible.

In another place, nearer the line, we got a great bore-hole sunk; but when we had proceeded about eight feet downwards, without meeting any indication of the rock, we abandoned the attempt.

Again, to the south of the railway, just inside the fence, the rock is smoothed, and slightly marked; but as you pass eastwards, the smoothing turns into a polish, and the polish becomes brighter and brighter till lost to sight by the rock dipping rapidly beneath the clay.

Out in the field, further to south still, a large extent of coarse, weather-worn rock comes to the surface; and here there is no polish nor smoothing of any description to be seen. Near this we sunk three boreholes through a shallow covering of about eighteen inches of earth. In two of these we found the rock accurately smoothed, while in the third it was brightly polished, grooved, and striated.

In the next field, to east of this, a deeper hole was sunk; and here again the result was satisfactory, the rock being polished.

The striations, when observed on a large scale on the ground, were parallel to the railway, or nearly magnetic east and west; and along with these the rock was deeply grooved in many places. But there is again a second series of marks, which bear about north-east and south-west.

Most of the groovings have coarse and jagged edges, and appear as if the rock was subjected to the sharp tearing and planing of some harder substance rubbed against it; in other cases the signs of rough treatment are no longer visible, and the surface appears rather as if it were slightly rippled than cut and indented by violent action.

What cause, then, would be likely to produce such stupendous effects as those which we have been just considering? Slipping mud will hardly account for it.

We must, therefore, once more have recourse to the old ice theory. But the question now arises, in what form did the ice work? Was it in the form of a glacier, or of an iceberg?

The shape and position of the side of the hill make the idea that the polishing and marking were caused by an iceberg seem not improbable. An iceberg bobbing up and down, as we often see a half-stranded cork on the shore, *might* apparently produce these effects; but, as was suggested to me by Mr. Close, if an iceberg were partially stranded, it would float about, moving on some great fixed centre; and thus all the markings and groovings would be huge uneven curves, or rough arcs of circles.

Further, if it were an iceberg, it is highly improbable that it is from the land side that it would approach, the polished rock being on the inland side of the hill.

What remains, then, for us to assume is, that the centre of Ireland was a great snow plain of considerably greater elevation above the sea than at present, and that numerous glaciers descended from it in various directions. One of these, going towards the west, encounters a small elevation in its course, is raised slightly up by it, presses with all its irresistible force against it—tears, grooves, marks, and polishes the opposing surface—and when it attains the top of the hill, goes along on its way over the snow, no longer touching or interfering with the rocks beneath till it is finally lost in the ocean.

So much, then, for the principal striæ, or those which run east and west; but there remain still another set of them, running north-east and south-west. These are very much inferior in depth and boldness to the others, and appear to be due to a subsequent action, namely, *the action of the Drift.* The large quantities of gravel, mixed with aluminous clay, differing from the surface earth, and the numerous boulders scattered about in all directions, give their undoubted testimony to the occurrence of drift action in this neighbourhood.

The direction of these marks, and the presence of the gravel to produce them, point both to the same conclusion, viz. that the minor striæ were caused by the drift; while, on the other hand, as was before stated, the greater striations, grooves, and polish are due to the direct action of ice, most probably in the form of a glacier.

XXV.—NOTES ON ANIMAL MECHANICS. By the REV. SAMUEL HAUGHTON, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, on Monday, May 23, 1864.

No. III.—*On the Muscular Mechanism of the Leg of the Ostrich.*

ON the occasion of the death of a fine male Ostrich, during the month of January last, in the Zoological Gardens of this city, I secured the body for dissection in Trinity College, and requested Mr. Macalister, of the Royal College of Surgeons, to avail himself of the opportunity thus afforded of completing the anatomical investigations he had previously commenced in the Royal Dublin Society, by the dissection of a female Ostrich, in the summer of 1863. Mr. Macalister availed himself of the opportunity, and has laid before the Academy such results of his dissections as seemed to him most worthy of record. My own attention was directed especially to the investigation of the muscular mechanism of the leg of the Ostrich, which I have long regarded as one of the most interesting pieces of mechanism in the animal kingdom, and I was fortunate enough to discover, in the digastric *rectus femoris* muscle, what I believe to be the key to the explanation of the complicated muscular apparatus of the Ostrich's leg.

The leg of the Ostrich is to be regarded as a long rod bent at four distinct points, which attains its greatest amount of shortening or bending at the moment the foot touches the ground, and which is suddenly straightened or elongated by the simultaneous contraction of all the muscles. The effect of the sudden elongation of the leg is, to throw the whole body of the bird forward, as if from a catapult, from the point of support of the foot; and while the body of the animal is thus projected through the air, the antagonist muscles that flex the several joints come into play, and are assisted in their action by some very remarkable contrivances in the heel joint, which I shall describe and figure.

It is necessary to the perfection of the mechanism, that the greatest possible amount of muscular force shall be expended in straightening or unbending the legs, alternately projecting the animal from foot to foot along the ground, the leg being at its maximum of flexure at the moment of touching the ground, and at its maximum of elongation at the moment of leaving it; and also, that the minimum possible amount of force shall be expended in flexing each leg, preparatory to its next spring, which must take place on touching the ground.

I shall show that the leg of the Ostrich fulfils these two conditions of perfect mechanism; but, before doing so, I shall describe in detail the muscles employed in the act of running by the Ostrich.

Part I.—Description of the Muscles.

1. A muscle, which must be regarded as a combined *tensor vaginæ femoris*, *glutæus maximus*, and *agitator caudæ*, takes its origin from the whole length of the posterior edge of the ilium (and first two caudal vertebræ) forwards to the commencement of the *symphysis iliaca*, *a, a, a* (Fig. 6), and is inserted as follows:—

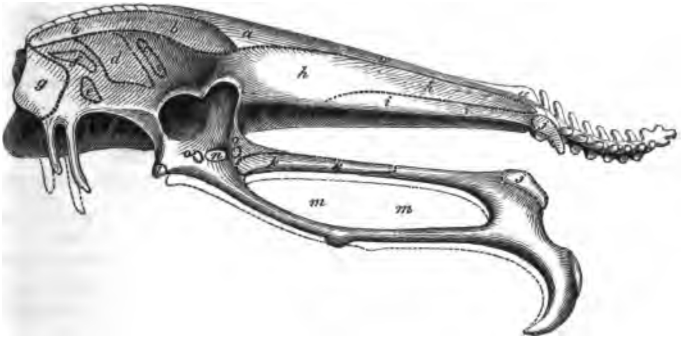
(α). The *tensor vaginæ* portion is inserted into a broad tendon, passing over the outer side of the knee; this tendon forming also one of the origins of the *gastrocnemius*.

(β). The *glutæal* portion of the muscle is inserted, partly like (α), and partly by a muscular slip, into the middle of the *vastus externus*.

(γ). The *caudal* portion of this muscle is inserted into the posterior border of the tendon (α), near the knee: the weight of the whole muscle is . . . . 46¾ oz.

2. *M. glutæus medius* has the origin marked *b, b*, in Fig. 6, on the surface of the ilium, and is inserted in the small pit, on the outside of the head of the femur (Fig. 7), and rather behind; its weight is . . . . 13¼ oz.

Fig. 6.



LEFT SIDE OF PELVIS OF OSTRICH.

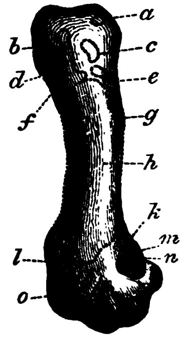
a, a, a,	Origin of *tensor vaginæ femoris, glutæus maximus,* and *agitator caudæ.*	*g,* . .	Origin of *sartorius.*
b, b, . .	,, *glutæus medius.*	*h, h,* . .	,, *biceps femoris.*
c, c, . .	,, *glutæus minimus.*	*i, i,* . .	,, *semimembranosus.*
d, . .	,, *iliacus.*	*j, j,* . .	,, *semitendinosus.*
e, . . .	,, *rectus femoris.*	*k, k,* . .	,, *adductor magnus.*
f, . .	,, *opponens quadrato-femoris* (or *iliocapsularis*).	*l,* . . .	,, *pectinæus.*
		m, m, .	Obturator foramen.
		n, . .	Ischiadic foramen.
		o, o, . .	Origin of *gemelli.*

3. *M. glutæus minimus* in the Ostrich is correctly so named, for it is a very small muscle; it arises from a thin line on the ilium, an inch and three-quarters in length, shown at *c, c*, Fig. 6, just behind the origin of the *iliacus*, and is inserted, with the *opponens quadrato-femoris*, below the great trochanter, on the front of the femur (Fig. 7); its weight is . . . . 1 oz.

4. *M. biceps femoris* has a bony origin, below that of the *glutæus maximus* on the ilium, and lies along the entire surface of the bone, between that muscle and the *semimembranosus, h, h* (Fig. 6); it is inserted into the tubercle in the middle of the fibula; its weight is . . . 41¼ oz.

5. *M. semitendinosus* takes its origin from the bony prominence of the posterior extremity of the ilium, from the tuber ischii, and the membrane that joins these two points, *j, j* (Fig. 6), and is inserted into the inner margin of the upper and posterior surface of the tibia; its weight is . . . . 14 oz.

Fig. 7.



OUTER SIDE OF LEFT FEMUR OF OSTRICH.

a, Insertion of *obturator*.
b, Origin of *vastus externus*, No. 1.
c, Insertion of *glutæus medius*.
d, „ *glutæus minimus*.
e, „ *quadratus femoris*.
f, „ *iliocapsularis*.
g, „ *semimembranosus*.
h, Origin of *vastus externus*, No. 2.
k, Insertion of *adductor magnus*.
l, Origin (A, β) of *flexores digitorum*.
m, „ (γ), *gastrocnemius*.
n, „ (A, α) *flexores digitorum*.
o, „ (β) *gastrocnemius*.

A remarkable accessory muscle arises from the insertion of the *adductor magnus* (Fig. 7) in the femur, and is fastened into the tendon of the *semitendinosus*, near its insertion into the tibia. This accessory muscle weighs 1 oz., and runs nearly at right angles to the tendon of the *semitendinosus*. Its action is to lift and guide the tendon, so as to increase the force of the *semitendinosus* in propelling the body forwards when the foot is fixed. The mechanical use of this muscle is similar to that of the *accessorius flexori digitorum longo* in the sole of the human foot.

6. *M. semimembranosus* has its origin on the ilium, below the biceps, as shown at *i, i*, Fig. 6; and is inserted in a line commencing at the top of the *linea aspera* of the femur (Figs. 7, 8), and extending to the fascia of the thigh down as far as the inner side of the knee; its weight is . . . . 17 oz.

The similarity of its use to that of the *glutæus* (1) is shown by the circumstance that it sends a slip (1½ oz.) backwards to the sides of the first two or three caudal vertebræ, which must be regarded as an additional *agitator caudæ*.

7, 8. *M. vastus externus* is composed of two parts—

M. v. e. 1. Having an inverted ⊥-shaped origin from the great trochanter, between the insertions of the *glutæus medius* and *minimus* (Fig. 7); it is inserted on the outer side of the capsule of the knee joint; its weight is 25½ oz.

Its action is to the outside of the plane that coincides with the greatest diameter of the highly elliptical cross section of the femur.

M. v. e. 2. Arises from the whole outer surface of the femur (Fig. 7); it has an insertion similar to that of *M. v. e.* 1; its weight is . . . 5 oz.

9, 10. *M. vastus internus*, like the preceding, is composed of two parts, whose origins are shown in Fig. 8—

M. v. i. 1. Arises from the upper and inner surface of the femur, and is inserted into the inner side of the head of the tibia, into the inner edge of the patella and of the ligamentum patellæ; its weight is . . . . 13½ oz.

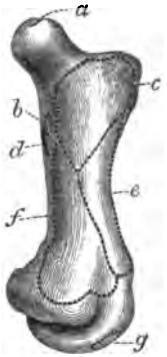
M. v. i. 2. Arises from the lower portion of the inner surface of the femur, and is inserted into the tendon of the former (*M. v. i.* 1); its weight is . . . . 3¾ oz.

The resultant plane of these two muscles lies as much to the inside of the plane of maximum strength of the femur, as that of the *vasti externi* lies to the outer side of the same plane.

11. *M. cruræus.*—Its origin, which lies altogether on the inner side of the femur, is shown in Fig. 8; it is inserted without a tendon into the patella; its weight is . . . 7¼ oz.

Its plane of moment coincides very nearly with that of the *vasti interni*, just described; and it is almost impossible to avoid coming to the conclusion, that the peculiar elliptical cross section of the femur, and its longitudinal plane of maximum strength, are contrived with reference to the strain of these muscles, so as to enable the slight and delicate structure of the femur (peculiar to all birds), to resist the action of the forces brought to bear upon it, and which exceed in magnitude those acting on the limbs of most quadrupeds.

Fig. 8.



INNER SIDE OF LEFT FEMUR OF OSTRICH.

a, Insertion of *ligamentum teres.*
b, „ *iliacus.*
c, Origin of *vastus internus*, No. 1.
d, Insertion of *semimembranosus.*
e, Origin of *cruræus.*
f, „ *vastus internus*, No. 2.
g, „ *tibialis anticus.*

12. *M. rectus femoris* is not correctly described in any book that I have seen; and its true nature, and connexion with the muscles of the calf, were discovered by me quite accidentally. I had taken for granted, as a matter of course, that the *rectus femoris* terminated in the patella; but, as there were two patellas, I wished to know in which of them the muscle terminated: on dissection, to my surprise, I found that instead of ending in either patella, its tendon passed in a groove over and between them both, and, turning outwards and backwards into the calf of the leg, became provided with a second muscular belly, which formed one of the portions of the *flexor digitorum magnus*, the conjoined tendon of which passed under the heel, and terminated in the plantar surface of the toe.

The *rectus femoris*, with its tendon, is therefore truly a digastric muscle, upwards of five feet in length (Fig. 9), and has its origin in the anterior bony prominence of the ilium, *e*, (Fig. 6), which is well marked on every pelvis of the Ostrich that I have seen. The tendon of this digastric muscle is united to that of the *gastroenemido-solæus*, by a slip shown at *a*, Fig. 9.

The weight of the fleshy belly of the *rectus femoris* proper is 7¼ oz.

13. *M. sartorius.*—This important and remarkable muscle arises from the anterior portion of the ilium, *g*, (Fig. 6), and from some of the spines of the lumbar vertebræ; and, passing in the usual manner across the inner aspect of the thigh, is inserted into the inner side of the ligamentum patellæ and into the top of the tibia; its weight is . . 18 oz.

14. *M. iliacus*—Has a lozenge-shaped origin on the anterior portion of the ilium, between the *opponens quadrato-femoris* and *glutæus minimus*, *d*, (Fig. 6). Its insertion into the femur is shown in Fig. 8, at a point which must be supposed to represent the lesser trochanter; its weight is . . . . 1¾ oz.

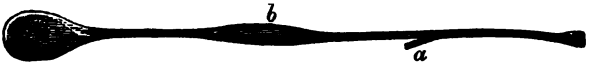
15. *M. gracilis* arises, like the *semitendinosus*, from the tuber ischii, and from the lower half of the ligament joining it to the posterior spine of the ilium; and is inserted into the fascia of the inner side of the knee joint; its weight is . . . . 4½ oz.

16. *M. adductor magnus* arises from the anterior half of the ischial line, *k*, *k* (Fig. 6), and is inserted into the upper margin of the condyloid pit at the back and inner side of the femur (Fig. 7); its weight is . . . . 4¾ oz.

Its fibres were pale and fatty in the specimen dissected by me.

17. *M. pectinæus* arises from the pectinæal point, *l*, (Fig. 6), and is inserted into the tibia on the inner side of the knee, and is intimately connected by muscular fibres with *vastus internus* (2); its weight is 4 oz.

Fig. 9.



DIGASTRIC MUSCLE,

Composed of *rectus femoris* and part of the *flexor digitorum magnus*.

a Tendinous slip, uniting the tendon of Digastric muscle with that of the Gastrocnemido-solæus.
b, Fleshy line of union with main body of the *Flexor digitorum communis*.

The blending of the fibres of *pectinæus* with those of the *vastus internus*, a portion of which, like this muscle, terminates directly in the tibia, is not to be forgotten in considering the mechanical action of the muscles of the hip and knee joints.

18. *M. quadratus femoris* has an origin on the ischial line, just below that of the *M. adductor magnus*, and an insertion of a linear shape in the back of the upper portion of the femur, shown in Fig. 7; its weight is . . . . 2¾ oz.

19. *M. opponens quadrato-femoris.*—This muscle I have so named, because it is met with in many animals as the direct opponent of the

quadratus femoris. In the muscular system of the Ostrich and Lion this antagonism between the muscles is very striking. It is found occasionally in human subjects, and is described by Harrison under the name of *M. ilio-capsularis.* While we had the Ostrich in the Dissecting Room of Trinity College, a human subject was brought in, which had the ilio-capsular muscle fully developed; and my attention was called to it by Dr. Bennett. I have occasionally found the ilio-capsular muscle in dissecting Monkeys.

In the Ostrich, the *M. opponens* has an origin on the anterior surface of the ilium, between those of the *Mm. sartorius, rectus, iliacus,* and *glutæus medius,* as shown at *f,* (Fig. 6); and is inserted in the anterior ridge at the base of the great trochanter, with the *M. glutæus minimus* (Fig. 7), with the fibres of which it is connected; it weighs . . . 1¾ oz.

20. *M. obturator.*—In the Ostrich, as in most birds, the internal and external obturator muscles are united, arising from both the inside and outside of the bony circumference of the obturator foramen, and from both sides of the obturator membrane; their common tendon passes through the ischiadic notch, *n,* (Fig. 6), which forms a pulley, changing the direction of the force through 90°, and receives, on emerging from the notch, the fibres of the little *gemelli,* placed at each side, anterior and posterior, to guide the obturator tendon to its insertion (Fig. 7) on the outer part of the top of the femur; it weighs . . . . . 17½ oz.

21, 22.—*Mm. gemelli* weigh . . . . ¼ oz.

23.—*M. coraco-clavicularis.*—In the wing of the Ostrich there is a very remarkable muscle, which arises from the bony margin of the coraco-clavicular foramen; this foramen corresponds in the upper extremity with the ischiado-pubic or obturator foramen of the lower extremity; and the muscle, passing under a strap ligament on the shoulder to be inserted in the outer part of the great tuberosity of the humerus, corresponds with the obturator muscle of the leg.

I consider this muscle to be the second pectoral of ordinary birds, and to be the proper *levator humeri.* It is usually placed between the first and third pectorals, on the sternum, and lifts the wing by means of a pulley, which changes its direction through 135°. This contrivance is necessary in birds of flight, in which it is of as much importance to stow the weight aft, as it is in ships to place the foremast well forward; but, as the Ostrich is a running bird, the Divine Contriver has left the second pectoral to lift the humerus by a direct pull, without expending any ingenuity on pulleys to change its direction, as is absolutely necessary in birds of powerful flight such as the Falcon, in which the pulley of the second pectoral is as remarkable a contrivance as the pulley of the obturator muscle in the Ostrich.

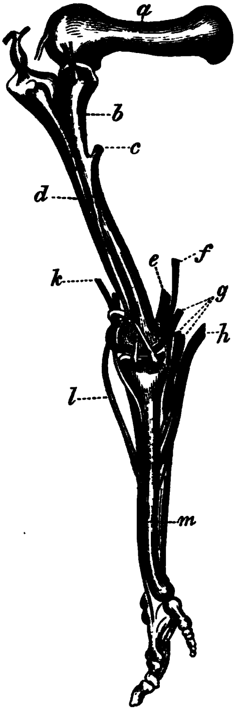
In fact, throughout the whole range of the muscular mechanism of various animals, every pulley changing the direction of an original force presents a problem to be solved; and tells us of a contriving mind, which has deviated, for some purpose discoverable by us, from the simple contrivance of muscular fibres pulling directly from their origin to their insertion.

24. *M. gastrocnemido-solæus.*—This great muscle has four distinct heads—

(*a*). From the outer side of the patella and of the ligamentum patellæ.

(*β*). From the external condyle of the femur (Fig. 7.)

Fig. 10.



LEFT THIGH, LEG, AND FOOT OF THE OSTRICH.

a, Femur.
b, Fibula.
c, Insertion of *biceps*.
d, Tibia.
e, Tendon of *solæus*.
f, „ *rectus femoris*.
g, Tendons of *flexores digitorum*.
h, Tendon of *gastrocnemius*.
k, „ *tibialis anticus*.
l, „ *extensor digitorum*.
m, Metatarsus, or cannon bone.

(*γ*). From the condyloid pit of the inner condyle, between the *Adductor magnus* and *Flexor digitorum* (Fig. 7).

(*δ*). From the tubercle of the tibia at both sides, and from the surface of the lower patella, and by means of fascia, to the upper part of the fibula.

Altogether it weighs . . . 115½ oz.

This enormous mass of muscles represents the *gastrocnemius* and *solæus*, intimately connected in their fleshy portion, but distinct both in origin and insertion. It is inserted, as shown in Fig. 10, by means of two powerful tendons into the upper and back part of the metatarsus, the tendon of the *solæus* being a little above that of the *gastrocnemius*.

It may be regarded as acting from the circumference of a ring placed all round the knee joint, to the tendo Achillis; and its resultant pull is nearly in the axis of the leg.

25. *MM. flexores digitorum.*—These important muscles may, in the Ostrich, be divided into two distinct groups:—

A.—This group arises from a triple origin:—

(*a*). The condyloid pit of the femur, below the origin of the Gastrocnemius (Fig. 7).

(*β*). From the outer side of the outer condyle of the femur (Fig. 7).

(*γ*). A fleshy slip connects these flexors with the belly of the digastric *rectus femoris* in the calf of the leg. This slip is represented, cut off at the point *b*, in Fig. 9.

Their total weight is . . . . 16 oz.

B.—This group has a double origin:—

(*a*). From the condyloid pit of the femur.

(*β*). From the whole back of the fibula and tibia, except that part which is covered by the *poplitæus*.

Their total weight is . . . . 9¾ oz.

26. *M. tibialis anticus.*—This is a flexor of the metacarpus, and arises from the two anterior tubercles of the tibia, and from the front of the external condyle of the femur (Fig. 8). It is inserted below the heel joint, by means of a split tendon, into the front of the metatarsal bone, two inches below the joint (Fig. 10). Its weight is . . . . 8¾ oz.

27. *M. extensor digitorum communis* (Fig. 10).—This muscle takes a fleshy origin from the tubercles of the tibia, and from the crest in front of the tibia. It is inserted into the toes, and into the annular ligament of the phalangeal joints. It has no action in flexing the metatarsal bone, except perhaps in some unusual positions of the foot. Its weight is . . . . 5¼ oz.

28. *M. poplitæus.*—Well marked, and rotates the fibula on the tibia. Weight, ... ¾ oz.

Part II.—Action of the Muscles.

In the act of running, the leg of the Ostrich is to be regarded as a jointed lever, having four joints, viz., the hip, the knee, the heel, and the metatarsal joints. As the animal springs from foot to foot, the whole limb on reaching the ground is bent as far as possible at each of the articulations; and when the spring is made, the muscles proper to each joint increase the angle made by the bones meeting at the joint, so that the effect of the whole is to unbend the limb, and give it a maximum of extension at the moment of leaving the ground. During the spring, the antagonist muscles again bend the joints, so that on next touching the ground it is at its maximum of flexion, again waiting to be unbent by the muscles that open the angles of the joint; and so on for ever, as the animal runs, it is thrown alternately from each foot in contact with the ground, as from a catapult, and advances by successive leaps or springs from foot to foot.

To take mathematical account of the moments of the muscular forces round each joint, it would be necessary to make the following measurements:—

Let O and I be the origin and insertion of any muscle, and A the centre of motion of the joint. The effect of the contraction of the muscle is to develope a moment or couple round the point A, acting in the plane OAI, and proportional to the weight of the given muscle, as already shown in Note I. If it be required to find the total effect of the muscles acting on a given joint with respect to any line, AX, we should have to find the angle made by each plane of moment, OAI, with the line AX; and so calculate by the usual rule of composition of moments the total effect of all the forces acting, and tending to produce rotation. Without going into minute detail, and taking only the muscles that act perpendicularly, or nearly so, to the transverse horizontal axis, we find the following muscles to represent the moment of the spring forwards:—

I.—*Muscles extending the Thigh on the Axis of the Body.*

1. Tensor vaginæ femoris,	46·75
2. Glutæus maximus,	
3. Agitator caudæ,	
4. Biceps femoris,	41·25
5. Semimembranosus,	17·00
6. Semitendinosus,	14·00
7. Gracilis,	4·50
8. Adductor magnus,	4·75
9. Pectinæus,	4·00
	132·25

II.—*Muscles extending the Leg on the Thigh.*

10. Rectus femoris,	7·25
11. Vastus externus, (1)	25·25
12. „ „ (2)	5·00
13. Vastus internus, (1)	13·50
14. „ „ (2)	3·75
15. Cruræus,	7·25
	62·00

III.—*Muscles extending the Metatarsus on the Leg.*

16. Gastrocnemido-solæus,	115·50
17. Flexores digitorum (A),	16·00
18. Flexores digitorum (B),	9·75
	141·25

The total combined effect of these muscles projecting the body forwards is therefore approximately represented by 335·50 oz. of Ostrich muscle.*

After the foot of the Ostrich has left the ground, and during his

---

* If we knew the weight of the Ostrich, and the length to which it can spring in a single maximum stride, we could easily calculate the work done in a single effort by a given weight of Ostrich muscle. I do not know how far an Ostrich in a state of nature can spring, nor how high, and am therefore unable to make the required calculation; but I give here two corresponding problems for man, which may be interesting to the physiologist.

Problem 1.—A cricket ball, weighing 5½ oz., is thrown a distance of 91 yards; find the work done by the muscles.

The thrower, by practice, finds the angle of maximum range, or 45°; and as

$$R = 2h \sin 2e$$

for the maximum range, h the height due to the velocity of projection is found to be 136·5 ft. This is the height to which 5½ oz. are raised, and therefore the work done is found to be 46·92 lbs. lifted through one foot.

Problem 2.—A young man, weighing 120 lbs., leaps horizontally 20 ft.; what is the work done? By the same method of calculating, we find the work done in this case to be 1200 lbs. lifted through one foot. This large amount of work is not given out in a single spring; for it represents the sum total of the single spring and of the velocity spring through the air, the following muscles are employed in flexing the several joints, so as to have them in readiness for another spring as soon as the foot touches the ground.

I.—*Muscles flexing the Thigh upon the Axis of the Body.*

1. Sartorius,	18·00
2. Iliacus,	1·75

II.—The flexure of the leg upon the thigh seems to be effected by the *vis inertiæ* of the former, when the latter is drawn up towards the body in the spring.

III.—*Muscles flexing the Metatarsus upon the Leg.*

3. Tibialis anticus,	8·75
4. Extensor digitorum communis,	5·25
	14·00

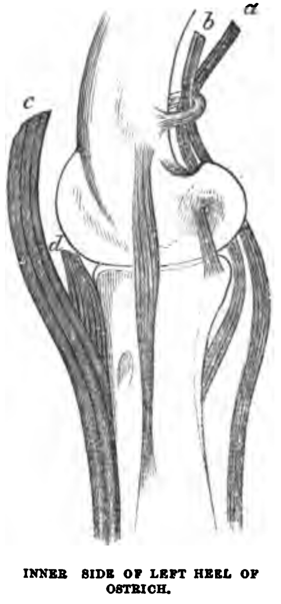
From this it would appear that the moments of the muscles flexing the joints of the limb, during the spring, are represented by 33·75 oz.

This is a small amount of force compared with that employed in extension, and in propelling the body forwards; but the flexor muscles are aided by *inertia*, and by a special contrivance in the heel joint, that remains to be described.

The articulating surfaces of the bottom of the tibia and top of the metatarsus, or cannon bone, are so formed, that it is easier to flex the joint forwards than backwards. This is effected by making the anterior curvature more rapid than the posterior curvature, which produces what connoisseurs in horses would call a beautiful "gig action;" and this natural disposition of the joint is further aided by two admirably contrived check ligaments, shown in Figs. 11, 12, which render the motion forwards much easier than that backwards.

In Fig. 11 I have shown the tendons of *M. gastrocnemius* and *M. solæus;* and in Fig. 12, the tendons of the *flexores di-*

Fig. 11.



INNER SIDE OF LEFT HEEL OF OSTRICH.

a, Tendon of *tibialis anticus.*
b, „ *extensor digitorum communis.*
c, „ *gastrocnemius.*
d, „ *solæus.*

---

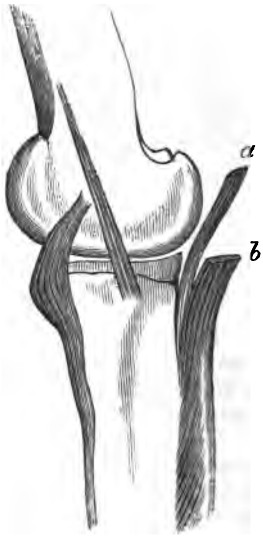
acquired in running up to the point of starting; and the whole art of long jumps resolves itself into jumping vertically with a velocity equal to the acquired horizontal velocity, and making both quantities a maximum.

gitorum communes, passing under and through the tendon of *M. gastrocnemius*.

In Fig. 11 are also shown the tendons of *M. tibialis anticus*, and *M. extensor digitorum communis*, passing through a common "dead eye" bolt—a contrivance necessary to keep them in their place on the flexure of the heel joint, and corresponding with the annular ligament of the human foot. In consequence of the arrangements just described, the foot of the Ostrich is jerked forward suddenly, after passing a position of unstable equilibrium, or "dead point," as it is called by mechanical engineers; and is slowly drawn backwards beyond that point by the action of the powerful extensors of the joint, when they are employed in making a spring.

Any observer who examines the gait of the Ostrich, Emu, Cassiowary, or Rhea, in confinement, cannot fail to be struck with the ungainly effect produced on the appearance of the animal, when walking slowly, by the abrupt and odd-looking lifting of the foot caused by the structure of the heel joint, giving an effect like that of string halt in horses; but this unpleasing impression would be rapidly converted into admiration, if he could see the bird in rapid motion over rough ground, springing from foot to foot, and bending the foot as it left the ground with the rapidity of lightning, avoiding skilfully, without an apparent effort, the dangers of the rough soil. I have been informed by eye-witnesses, that under such circumstances the Ostrich in South Africa almost touches the ground alternately on each side with its body, in every successive spring, and leaps with ease over rocks and shrubs of considerable dimensions that lie in its onward path.

Fig. 12.



OUTER SIDE OF LEFT HEEL OF OSTRICH.

a, Tendon of *flexor digitorum communis*.
b, „ *gastrocnemido-solæus*.

I have shown in the preceding part of this paper, that the force expended in propelling the body of the ostrich forward is ten times the force employed in restoring the legs of the animal, preparatory to its next spring; more exactly, as 335·5 to 33·75. This enormous force acts upon bony supports, which are required by the necessities of a bird's existence to be as delicate and light as possible; and it is, moreover, exerted almost instantaneously, so as to give the fullest effect to the bird's spring. The question naturally arises, how is this force to be suddenly applied, without breaking or dislocating the animal's legs?

The answer to this question is to be found in the peculiar structure of the *rectus femoris* muscle, which binds down the patellæ, straps up the heel, and brings the whole machine into harmony at the moment that the spring is about to take place.

The admirable mechanical economy of the leg of the ostrich may be illustrated by the parallel case of the Cornish pumping engine. Let us suppose a 100-inch cylinder engine about to commence its downward stroke, and to lift the pump rods, weighing many tons, by means of a force of steam which commences at a maximum, and is gradually let off by expansion to a safe and manageable quantity. It has been found by experience that it is necessary to cause a minute vibration of the beam before letting on the full force of the steam—such vibration shaking all the nuts and pins into their proper positions before the great and sudden action of all the parts takes place; and if such a precaution were to be omitted, it is well known that the sudden impulse of the steam would break the engine.

In the leg of the ostrich, the *M. rectus femoris* supplies the place of the preliminary vibration; it acts before the extensor muscles come into full play; it binds down the two patellæ, braces up the heel joint, and gives the signal for the *M. gastrocnemido-solæus* and other associated muscles to contract, and thus produces what may be regarded as one of the most striking phenomena in nature, viz., that the delicate bones and ligaments of a bird's leg, acted on by muscles equal to those influencing the hind leg of a horse, shall remain uninjured under the sudden action of forces, the slightest error in the application of which would break to pieces the machine on which they act.

I can admire, though I do not envy, the reasoning powers of those Naturalists who believe that a mechanism such as this grew out of pre-existing forms without the interposition of an intelligent mind; and for myself I must declare, that I could as easily believe that the modern Cornish engine had developed itself from its clumsy predecessors by the way of Natural Law, and without the interposition of intelligent engineers, as that the leg of the Ostrich was produced by Natural Selection from the commonplace legs of its less perfect ancestors.

XXVI.—NOTES ON ANIMAL MECHANICS. By the Rev. SAMUEL HAUGHTON, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, on Monday, May 23, 1864.]

No. IV.—*On the Muscular Anatomy of the Lion.*

DURING the month of January last a fine Lion died of fever in the Zoological Gardens of this city, which had lived there for upwards of twelve years. I purchased his body for the use of the Anatomical School of Trinity College, in which the dissections were made which are used in this paper. I am indebted to Mr. Little, Medical Scholar of Trinity College, for the drawings from which two of the woodcuts were copied. The animal was in fine condition; both fat and muscle being well developed, which was to be expected, as he died after a short illness, which commenced on the 27th of December, 1863, and terminated fatally on the morning of the 12th of January, 1864. The Lion died of fever, and his chance of recovery was destroyed by the occurrence of three days' frost during his illness. We had no means of protecting him from the cold, and from the still more deadly damp that followed it during the thaw; and notwithstanding that he rallied for one day, under the influence of stimulants, he ultimately succumbed to the disease, and died with all the symptoms of a human being in fever. The only pathological appearances found after death were—a small circumscribed patch of consolidation in the right lung, and traces of chronic rheumatic arthritis in the right shoulder joint.

PART I.—MUSCLES OF THE HIP AND KNEE JOINTS.

1. *M. biceps femoris* weighs . . . . $27\frac{3}{4}$ oz.

This muscle is shown in Fig. 13, and forms a massive triangular sheet, having for its origin the highest point of the *tuber ischii;* and is inserted by strong fascia continuously from the middle of the femur covering the *vastus externus*, down the entire length of the outer side of the leg, as far as the *tendo Achillis*, round which it is fastened. The total length of the muscular fibres from *tuber ischii* to *tendo Achillis* is $22\frac{1}{4}$ inches, and from *tuber ischii* to highest insertion on femur $8\frac{3}{4}$ inches; and when the leg is extended, the third side of the muscular triangle is $17\frac{1}{4}$ inches. If the whole sheet of muscle be supposed of uniform thickness (which was nearly the case), the simultaneous contraction of all its fibres will draw the base of the muscular triangle towards its origin, parallel to itself; and the resultant of all the forces will lie in the bisector of the vertical angle. This resultant must therefore divide the base in the proportion of $22\frac{1}{4}$ to $8\frac{3}{4}$ inches. On making the calculation, it is found that the resultant intersects the base at a point 12·38 inches above the *tendo Achillis*. This point corresponds with the knee joint, and the effect of the whole muscle is the same as that of a single linear muscle from the *tuber ischii* to the top of the fibula.

2. *M. bicipiti accessorius.*[*] This muscle is represented by a long slender slip, intimately associated with the *biceps*, two feet in length, passing from the *os calcis* to the posterior point of the sacrum. It is shown at K, Fig. 14.

3. *M. agitator caudæ* weighs 6½ oz.

Origin from 1st, 2nd, and part of 3rd caudal vertebræ.

Insertion, by a long tendon into the outer side of the patella. This muscle is shown at C, Fig. 14. Its use is to wag the tail in a feline, not canine fashion; and also to secure the proper action of the patella preparatory to a spring. This seems to be the final cause of the violent agitation of the tail, vibrated from its first and second vertebræ, that forms so remarkable a characteristic of all the Felines. Considered from this mechanical point of view, the function of the *agitator caudæ* in the Lion is similar to that of the *rectus femoris* in the Ostrich.

4. *M. semitendinosus* (G, Fig. 14), weighs, . . . 10 oz.

Origin from *tuber ischii.*

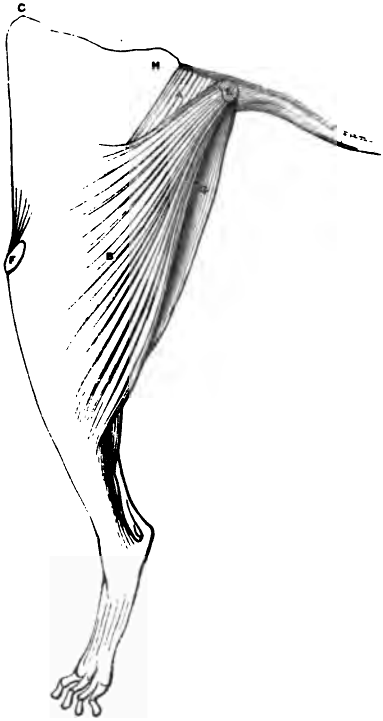
Insertion, at upper point of trisection of the *tibia.*

5. *M. semimembranosus* (H, Fig. 14), weighs . . 26¼ oz.

Origin, from *tuber ischii.*

Insertion, into head of *tibia,* with a broad fascial insertion above and below the knee joint.[†]

Fig. 13.



LEFT LEG OF LION.

(with skin removed, showing superficial layer of muscles).

A, *M. agitator caudæ.*
B, *M. biceps femoris.*
C, Crest of the *ilium.*
D, Tendinous insertion of posterior fibres of *biceps,* round *tendo Achillis.*
E, *Tuber ischii.*
F, *Patella.*
G, *M. semitendinosus.*
H, Great *trochanter.*

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[*] It was suggested to me by Mr. Little that this muscle was the representative of the *plantaris;* and as I had found it to occur in the Dog and Badger, I was disposed to regard it as the representative of this muscle in the Carnivores. I am compelled to abandon this view from the observation of the fact, that in the Otter, in which animal also it is found, there is a well-marked *plantaris* occupying its usual position in the calf of the leg.

[†] For details, *vide* Fig. 15.

The *biceps* and *semimembranosus* act in planes parallel to the plane of motion of the knee joint, and from their mode of action must both have resultants passing through the junction of the thigh and leg, so that they must be regarded as principally extensors of the thigh, and not as flexors of the leg. The *semitendinosus*, on the other hand, acts as a flexor of the leg, and seems to abduct by the same angle that *gracilis* adducts; so that, considering that their weights are nearly equal, the resultant of *gracilis* and *semitendinosus* will also lie in the plane of motion of the knee joint.

6. *M. gracilis* weighs 9 oz.

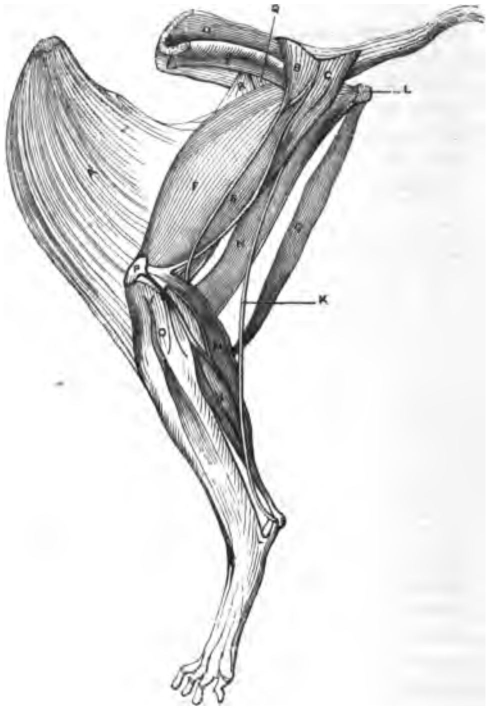
7. *M.** *adductor magnus* weighs 27¼ oz.

Origin, inner border of *symphysis pubis*, and round the edge of the *M. obturator externus*, as far as the *tuber ischii*.

Insertion, along the *linea aspera*, through entire length of the back of the *femur*.

8. *M. adductor longus* weighs . . 2¾ oz.

Fig. 14.



LEFT LEG OF LION.

(with *biceps femoris* reflected, to show the deeper muscles).

A, *M. biceps femoris*, reflected.
B, *M. glutæus maximus.*
C, *M. agitator caudæ.*
D, *M. glutæus medius*, its lower border reflected, to show,
E, *M. glutæus minimus.*
F, S, *M. vastus externus.*
G, *M. semitendinosus.*
H, *M. semimembranosus.*
K, *M. bicipiti accessorius.*
L, *Tuber ischii.*
M, *M. gastrocnemius.*
N, Portion of *gastrocnemius*, sending a separate tendon to the patella.
O, Lateral ligament of knee.
P, *Patella.*
Q, *M. iliocapsularis.*
R, *M. rectus femoris.*

---

* The action of the *adductor magnus* is one of the most complicated in animal mechanics—for its origin is a curve, and its insertion a line, and these lie in different planes. Probably, in the Lion, half its muscular force is expended in simple extension of the femur, and the remaining portion, as in man, opposes the *glutæus medius.*

9. *M. pectinæus* passes over lesser trochanter, and weighs . ¾ oz.
10. *M. glutæus maximus* (B, Fig. 14) weighs . . . . . 3½ oz.
Origin, from last *sacral* vertebræ.
Insertion, into glutæal trochanteric ridge, for 2½ inches.
11. *M. glutæus medius* (D, Fig. 14) weighs . . . . . 14½ oz.
These *glutæi* divide the interval from the first caudal vertebra to the crest of the ilium, equally.
12. *M. glutæus minimus* (E, Fig. 14) weighs . . . . . 2½ oz.
Origin, from the dorsum of the ilium.
Insertion, at inner side of great trochanter.
13. *M. tensor vaginæ femoris** weighs . . . . 6⅓ oz.
14. *M. sartorius* weighs . . . . 11¾ oz.
15. *M. rectus femoris* (R, Fig. 14), weighs . . . . . 11 oz.
16. *MM. vasti et cruræus*, ... 32 oz.
17. *M. psoas parvus*, ... 2½ oz.
18. *M. Psoadiliacus*, ... 10¾ oz.
19. *M. quadratus femoris*, ... 1·58 oz.
Origin, from *tuber ischii*.
Insertion, into posterior intertrochanter ridge.
This muscle acts in the plane of the knee joint.
20. *M. iliocapsularis* (Q, Fig. 14), weighs . . . . . . 0·53 oz.
Origin, from *ilium*, behind the origin of *rectus femoris*.
Insertion, into the front of the *femur*, on the line below the great trochanter.
21. *M. pyriformis* weighs . . . . 2½ oz.
22. *M. obturator externus* weighs . . . . 2·60 oz.
23. *M. obturator internus* weighs . . . . 4 oz.

It has been well observed by Cuvier, that man is remarkably distinguished from the Quadrumans, by the preponderance of the *glutæus maximus* over the other *glutæi*. This is essentially a bipedal characteristic, as is shown in the following comparative Tables:—

Comparison of Glutæal Muscles in Man.

	Man.
1. Glutæus maximus,	53
2. Glutæus medius,	34
3. Glutæus minimus,	13
	100 parts.

Comparison of Glutæal Muscles in the Macaque, the Lion, and the Ostrich.

	Macaque.	Lion.	Ostrich.
1. Glutæus maximus, Agitator caudæ, and Tensor vaginæ, combined,	28	49	76
2. Glutæus medius,	61	43	21
3. Glutæus minimus,	11	8	3
	100	100	100

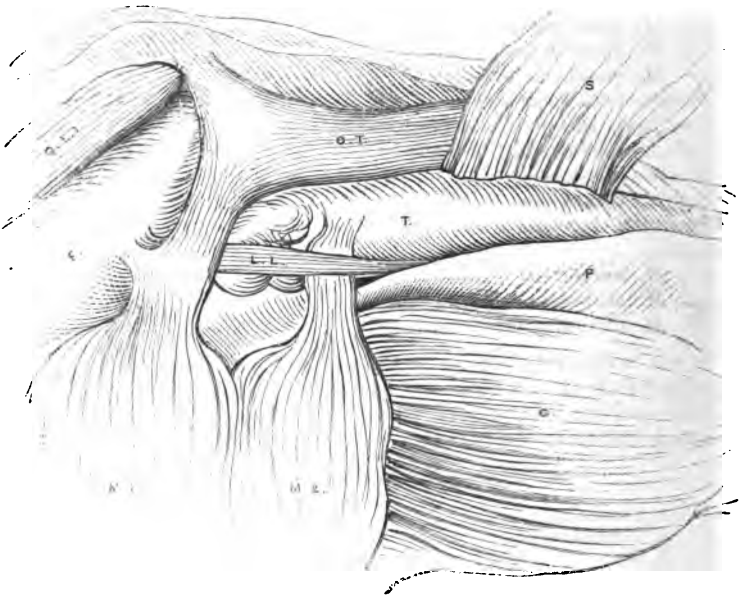
---

* The *tensor vaginæ* and *sartorius*, when acting in conjunction to flex the thigh, give a resultant in the plane of the knee joint.

Judged by the preceding comparative Tables, Man possesses the characteristic referred to, in a lesser degree than the Ostrich, in a greater degree than the Lion, and in a very much greater degree than the *Macacus Nemestrinus*. Strictly speaking, the Macaque is neither a biped like the Ostrich or Man, nor a quadruped like the Lion, but is a climber, and has relations of forces among the muscles of the posterior limb suited to that mode of locomotion.

The following figure, which shows the arrangement of the tendons at the inner side of the knee joint, was drawn from nature by my son, and will serve to explain any obscurity in the preceding descriptions of the muscles and their attachments:—

Fig. 15.



INNER SIDE OF LEFT KNEE OF LION.

F, *Femur*.
T, *Tibia*.
S, *M. sartorius*, reflected.
P, *M. poplitæus*
G, *M. gastrocnemius*.

Q, E, I, *M. quadriceps extensor internus*.
M 1, and M 2, Insertions of *M. semimembranosus* into the *tibia, femur*, and *patella*.
C, T, *Aponeurosis*.
L, L, Lateral ligament of knee joint.

Part II.—Action of the Muscles of the Hip and Knee Joints.

The most important of the muscles just enumerated exert their action in extending or flexing the thigh upon the body in the plane of motion of the knee joint, which is parallel to the brim of the acetabulum in ordinary positions of the leg.

They may be classed as follows:—

1. *Extensors of Thigh.*

	Ozs.
1. Biceps femoris,	27·75
2. Semitendinosus,	10·00
3. Semimembranosus,	26·25
4. Gracilis,	9 00
5. Adductor magnus,*	13·62 ?
6. Adductor longus,	2·75
7. Quadratus femoris,	1·58
Total moment of Extension of Thigh,	90·95 oz.

2. *Flexors of Thigh.*

	Ozs.
1. Tensor vaginæ femoris,	6·50
2. Sartorius,	11·75
3. Psoadiliacus,	10·75
Total moment of Flexion of Thigh,	29·00 oz.

From the preceding it appears that the total moment of extension exceeds that of flexion in the proportion of 91 to 29, nearly, or more than three times.

Let us now suppose the thigh flexed on the body at an angle of 45°, as it would be preparatory to a spring, and consider the action of the remaining muscles of the hip joint. They all tend to turn the femur in planes perpendicular to the plane already considered, and which all pass through the axis perpendicular to the brim of the acetabulum.

I examined carefully the azimuths of the planes of motion of these muscles on the rim of the acetabulum, in the position of the thigh described, and found them to be as follows, counting from right to left, on the left leg of the Lion:—

Rotators of Thigh.

Muscles.	Azimuth.	Moment. Ozs.
1. Obturator externus,	0°	2·60
2. Pectinæus,	60	0·75
3. Ilio-capsularis,	149	0·58
4. Glutæus minimus,	167	2·50
5. Glutæus medius,	193	14·50
6. Pyriformis,	266	2 50
7. Glutæus maximus,	266	8·50
8. Obturator internus,	277	4·00
9. Agitator caudæ,	277	6·50
10. Adductor magnus,	360	13·62 ?
Total moment of Muscles rotating the Thigh,		51·00 oz.

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* Half the force of the *adductor magnus* is here supposed to act in the plane of motion of the knee joint.

It is probable that the muscles here given as rotators never act together in one leg only, for the Lion never attempts to stand on one leg; but it may be useful to calculate what would be the direction and magnitude of their total resultant. Assuming the plane of the component couple X to be that of the muscles *obturator externus* and *adductor magnus*, we find—

$$X = 16{\cdot}22 + 0{\cdot}75 \cos 60^\circ - 0{\cdot}53 \cos 31^\circ - 17 \cos 13^\circ - 6 \cos 86^\circ + 10{\cdot}5 \cos 83^\circ = 0{\cdot}29 \text{ oz.}$$

$$Y = 0 + 0{\cdot}75 \sin 60^\circ + 0{\cdot}53 \sin 31^\circ - 12 \sin 13^\circ - 6 \sin 86^\circ - 10{\cdot}5 \sin 83^\circ = -18{\cdot}18 \text{ oz.}$$

$$\frac{Y}{X} = -\tan (89^\circ \, 5')$$

$$\sqrt{Y^2 + X^2} = 18{\cdot}18 \text{ oz.}$$

The resultant moment of all the muscles causing rotation lies, therefore, in a plane nearly perpendicular to the plane of the *obturator externus*, and is represented by a weight of lion flesh of 18·18 oz. acting towards the body.

When the Lion crouches on his haunches, with his feet somewhat apart, and knees approximated, acting as fulcra, the origins and insertions of the rotator muscles are converted, and they all become available to assist in his spring, which is thus aided by the propulsion of the haunch upwards by the joint action of the rotator muscles of both legs; and his body is at the same time propelled forward by the action of all the extensors of the thigh, leg, and foot of both sides.

PART III.—MUSCLES OF SHOULDER AND ELBOW JOINTS.

1. *M. pectoralis major,* . . . . 34¼ oz.
    Origin, from whole length of sternum.
    Insertion, into whole length of pectoral ridge of humerus, with a slip joining the *deltoido-trapezius* as it passes on to be inserted in the radius.
2. *M. pectoralis minor,* . . . . 7¾ oz.
3. *M. deltoido-trapezius,* . . . . 15¾ oz.
    This conjoined muscle forms a large sheet, covering the scapula and head of humerus, and flowing freely over them in the rapid actions of the arm; it is inserted partly into the moveable clavicle, and partly into the inner side of the ulna, one inch below the elbow joint.
4. *M. deltoideus proprius,* . . . . 4¾ oz.
    Origin, anterior third of spine of scapula.
    Insertion, deltoid ridge on outer side of humerus.
5. *M. cleido-mastoideus,* . . . . 4¼ oz.
    This muscle has a double origin, from the mastoid process and from the transverse process of the dentatus; it is inserted into the floating clavicle.

6. *M. levator anguli scapulæ*, ... 2¼ oz.
Origin, from the fascia in the upper part of side of neck.
Insertion, into the anterior extremity of the vertebral edge of the scapula.

7. *M. serratus magnus*, ... 20¾ oz.

8. *M. rhomboideus major*, ... 7¾ oz.
This muscle is inserted into the vertebral edge of the scapula, and rotates it in a direction opposite to that of the *serratus magnus.*

9. *M. rhomboideus minor*, ... ½ oz.
This muscle, though rudimentary, is distinct.

10. *M. supraspinatus*, ... 14½ oz.

11. *M. infraspinatus*, ... 13 oz.

12. *M. subscapularis*, ... 14¾ oz.

13. *M. triceps*, ... 43½ oz.

14. *M. teres major*, ... 9½ oz.
Origin, whole posterior edge of the scapula.
Insertion, into the middle third of the humerus, by means of a flat tendon.

15. *M. latissimus dorsi*, ... 25½ oz.

This vast sheet of muscle is inserted into the middle of the tendon of the *teres major*, at four inches distant from the humerus.

16. *M. biceps*, ... 8 oz.

17. *M. brachialis externus*, ... 4 oz.

18. *M. coraco-brachialis*, ... ¼ oz.

This muscle is rudimentary, but regular, and possesses a long tendon, also rudimentary.

PART IV.—MUSCLES OF MASTICATION.

1. *M. masseter.*

This muscle is divided into two distinct portions; one external, with fan-shaped fibres radiating from the angle of the jaw, and more or less horizontal; and the other internal, with vertical fibres, arising from the whole internal surface of the zygoma, and inserted into the masseteric cavity of the ramus.

The external, or horizontal portion, weighs . . . . . 11 oz.
The internal, or vertical portion 6½

The second portion of the *masseter* is a direct closer of the mouth.

2. *M. temporalis.*

The temporal muscle is also divided into two; one superficial, arising partly from the superficial fascia, and partly from the margin of the temporal fossa, behind the ear, and from the back of the orbit; this portion, in passing downwards to the coronoid process, becomes blended with the internal portion of the *masseter* on the outer side, and with the second portion of the temporal on the inner side.*

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* This superficial portion of the temporal muscle is well seen in the Otter, in which animal it is better separated from the masseter, and from the true temporal, than in the Lion.

The second part of the temporal muscle has the usual origin and insertion.

The superficial temporal weighs . . . . 6 oz.
The true temporal, ... 16½ oz.

The vertical fibres of the *masseter* close the jaw directly without producing any pressure on the joint; but the fan-shaped fibres of this muscle cause a powerful pressure on the condyle of the lower jaw, forcing it backwards into its socket. Such seems to be also the function of the superficial fibres of the temporal muscle, which press the condyle into its socket, as well as close the mouth. This pressure seems to be necessary, in consequence of the habit the Lion has of carrying his prey in his mouth for a long time before he devours it; for the weight so carried would inevitably dislocate the jaw, if there were not a special provision made in the action of the masticating muscles to guard against it.

3. *MM. pterygoidei.*

The first part of these (*externus*) weighs . . . . ¾ oz.

Its origin is the posterior portion of the pterygoid plate, and it is inserted into the *masseter* muscle at the angle of the jaw. Its action is to draw the fibres of the masseter forward, and give them a longer leverage.

The second portion of the pterygoid muscle (internus) weighs 2 oz.

It arises from the anterior portion of the pterygoid plate, with an extensive origin also from the floor of the orbit, and is inserted two inches from the angle of the jaw.

Its action is to close the jaw, and draw it forward.

4. *M. digastricus,* . . . . 2½ oz.

This is the proper muscle for opening the mouth in all the carnivora.

Its origin is the mastoid process.

Its insertion is into a line 3½ inches in length backwards from the symphysis of the jaw, along the mylo-hyoid ridge.

XXVII.—NOTES ON ANIMAL MECHANICS. By the Rev. SAMUEL HAUGHTON, M. D., Fellow of Trinity College, Dublin.

[Read before the Royal Irish Academy, on Monday, June 13, 1864.]

No. V.—*The Muscular Anatomy of the Seal.*[*]

THE muscular anatomy of the Seal differs in many important particulars from that of the other Carnivores; and this difference seems to be occasioned principally by its aquatic habits, which render it better adapted for locomotion in the water than on dry land. In the anterior limbs, everything is sacrificed to the swimming action of the arms, which seem to be placed in the centre of elliptical masses of muscles converging to a common centre, the fibres of which, by their successive contraction, produce the monotonous circular motion requisite for swimming; while the feathering action of the hand is provided for by powerful supinators. In the posterior extremity the swimming action is more like that of the tail of the fish, and consequently the feet are blended with the tail, and their swimming action is effected chiefly by lowering the insertions of all the muscles, thus sacrificing the delicate motions of the thigh to the coarser action of the whole leg, considered rather as a portion of the tail than as a distinct member of the body.

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[*] The drawings from which the woodcuts were made were taken from nature by my son.

Notwithstanding this subordination of the function of the muscles in both extremities to the purposes of a single and simple action, it is wonderful to observe how perfectly each muscle retains its individuality; so much so, indeed, that there are few animals whose muscles in both limbs are more perfectly developed than are those of the Seal.

Part I.—Muscles of the Anterior Limbs.

1. *M. pectoralis major*, ... 10 oz.

   This muscle arises from the whole length of the sternum (14 inches), and is inserted into the well-marked pectoral ridge of the humerus; its fibres are succeeded at the xiphoid cartilage by the converging fibres of the next muscle, which forms the lower half of the superficial muscular ellipse, having its centre at the head of the humerus.

2. *M. latissimus dorsi superficialis*, ... 18 oz.

   Origin; usual origin from posterior aspects of posterior ribs and back, in front blending with the *panniculus carnosus*, it takes an origin from the anterior line of the pelvis and mesian line of the abdomen, completing its semielliptical origin at the xiphoid cartilage, where it is succeeded by the great pectoral.

   Insertion; by means of a tendon common to it and *great pectoral* into pectoral ridge.

3. *M. Trapezius*, ... 4½ oz.

   Origin; from all the cervical and dorsal vertebræ.

   Insertion; into the outer side of head of humerus, and into the spine of the scapula.

   This muscle continues through another quadrant the elliptical circuit of muscles commenced by Nos. 1 and 2.

4. *M. humero-occipitalis*, ... 4 oz.

   Origin; from posterior line of the aponeurotic origin of the temporal muscle.

   Insertion; pectoral ridge of humerus, inner side.

   This muscle is continuous with the *trapezius* behind, and with the *pectoralis major* in front, and completes the elliptical circuit of superficial muscles, which may be regarded as an essential characteristic of aquatic quadrupeds. It corresponds to the superior part of the human trapezius, which is inserted in the clavicle.

5. *M. Sternomastoideus.*

The sternal portion of the mastoid muscle is represented in the Seal by two distinct muscles—

(*a*)—The first having its origin inside the top of the sternum, and its insertion, by a fine tendon, into the mastoid portion of the temporal bone, ... 1 oz.

(*b*)—The second having its origin from the whole length of the first rib; and its insertion into the under part of the lower jaw, near the symphysis.

6. *M. Omo-atlanticus*, ... 1¼ oz.

Origin; from transverse process of the atlas.

Insertion; into the top of the pectoral ridge of the humerus, on the outer side.

This is the muscle which I have described in Note 2, as occurring in *Cercopithecus* and *Macacus*, under the name of *trachelo-acromius*, of Cuvier. In the Seal, its insertion is shifted from the spine of the scapula to the humerus, where it assists the general swimming or rotatory action of the limb.

7. *M. levator anguli anterioris scapulæ*, ... ¾ oz.

Origin; from the transverse process of the atlas.

Insertion; into the vertebral edge of the scapula, at the end of the scapular ridge.

This is the *levator anguli scapulæ* of anthropotomists, with origin and insertion somewhat shifted; it is really a portion of the *M. serratus magnus*.

8. *M. serratus magnus*, ... *not recorded.*

Origin; from the transverse processes of the cervical vertebræ from the 2nd to the 7th.

Insertion; into the vertebral edge of the scapula, behind its spine.

9. *M. levator anguli posterioris scapulæ*, ... 1½ oz.

Origin; central portion of occipital ridge.

Insertion; posterior exterior angle of vertebral edge of scapula; marked *d*, Fig. 17.

The mechanical action of both levators is similar.

10. *M. latissimus dorsi proprius*, ... 3¾ oz.

The true *latissimus dorsi* underlies the superficial, already noticed, and consists of two parts, quite distinct, viz.—

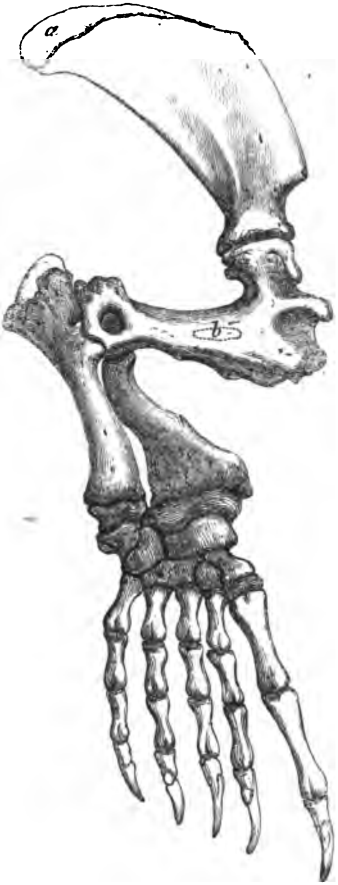
(1) Humero-dorsalis, ... ¾ oz.

(2) Scapulo-costalis, ... 3 oz.

The first of these muscles (1), or *humero-dorsalis*, represents the *latissimus dorsi* of anthropotomists; its origin is from the spinous processes of the posterior dorsal vertebræ and from their ribs; and its insertion is by means of a tendon common to it and the *M. teres inferior* into the inner side of the upper part of the humerus, at the line marked (*b*) in Fig. 16.

Its action is to rotate the arm inwards, and extend it upon the body; and it also serves mechanically, to keep the posterior angle of the scapula close to the ribs, for in passing to its insertion in the humerus, it overlaps the scapula over the space marked (*a*) in Fig. 17, which also represents the origin of the *teres inferior* muscle.

Fig. 16.



INNER SIDE OF LEFT ANTERIOR LIMB OF SEAL.

a, Insertion of *M. latissimus dorsi scapulo-costalis.*
b, ,, *M. latissimus dorsi humero-dorsalis*, and *M. teres inferior.*

The second part of the true *latissimus dorsi* muscle, (2) called *scapulo-costalis*, has an abdominal origin (with indigitations), corresponding to the dorsal origin of the *humero-dorsalis*, beneath which it passes to be inserted on the inner face of the cartilaginous prolongation of the vertebral edge of the scapula marked *a* in Fig. 16. These two muscles form a portion of an inner elliptical plane of converging fibres, corresponding to the outer plane of the superficial *latissimus dorsi*, whose function as a swimming muscle has been already noticed.

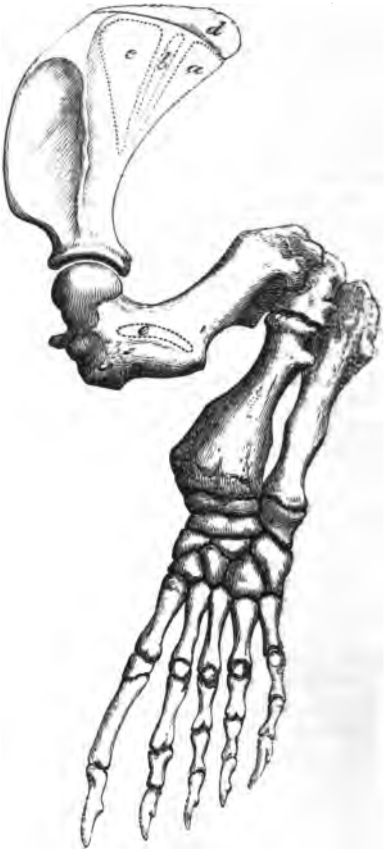
11. *M. teres inferior*, . . ½ oz.
    Origin; marked *a* in Fig. 17.
    Insertion; by tendon common to it and *latissimus dorsi humero-dorsalis* into line marked *b*, in Fig. 16.
12. *M. teres superior*, . 1·47 oz.
    Origin; triangular space on outer side of scapula, marked *c*, Fig. 17, and from spine of scapula.
    Insertion; outer side of pectoral ridge, along line marked *e*, Fig. 17.
13. *M. supraspinatus*, . 1·85 oz.
14. *Infraspinatus*, . . 0·47 oz.
    Inserted just above the *teres superior*, on the humerus.
15. *M. subscapularis*, . . 5·5 oz.
16. *M. triceps*, ... 5·0 oz.

This muscle has two scapular and one humeral head; one of the scapular heads is marked *b*, Fig. 17, the other is near the glenoid cavity, and the humeral head is as usual in all mammals.

17. *M. tricipiti accessorius*, ... 0·57 oz.

This muscle is superficial, and has its origin in the fascia underlying the skin of the back of the arm—it aids the *triceps*, and also braces up the skin of the back of the arm.

Fig. 17.



OUTER SIDE OF LEFT ANTERIOR LIMB OF THE SEAL.

a, Origin of *teres inferior*.
b, One of the scapular origins of *triceps*.
c, Origin of *teres superior*.
d, Insertion of *levator anguli posterioris scapulæ*.
e, „ *teres inferior*.

18. *M. anconæus*, . . . 0·23 oz.

Origin; back of inner condyle.

Insertion; inner side of olecranon process.

19. *M. biceps humeri*, . 1·20 oz.

20. *M. brachialis externus* = *Supinator radii longus*, 0·20 oz.

Origin; line on humerus in continuation of that of the insertion of *teres superior*.

Insertion; anterior superior *crest of radius* (*styloid process*), by means of strong twisted tendinous fascia.

21. *M. brachialis anticus*, 0·35 grs.

Origin; whole outer surface of humerus, below the insertion of *teres superior* (Fig. 17, *e*), and origin of *brachialis externus*.

Insertion; upper and back side of ulna, on a line level with the insertion of the biceps into the tubercle of the radius.

22. *Pronators*, . . . 1·55 oz.

viz., 1. *Pronator radii teres*,
2. *Flexor carpi radialis*,
3. *Flexor communis, digitorum*.

These have their origin from the inner condyle of the humerus.

23. *Flexors* of wrist, having their origin from the olecranon process, ... 1.63 oz.

viz.
1. *Flexor carpi ulnaris,*
2. *Flexor digitorum communis,*
3. *Natatorius cuticularis.*

24. *Supinators* having origin from external condyle of humerus, 0·85 oz.
viz.
1. *Extensor carpi radialis,*
2. *Supinator lævis.*

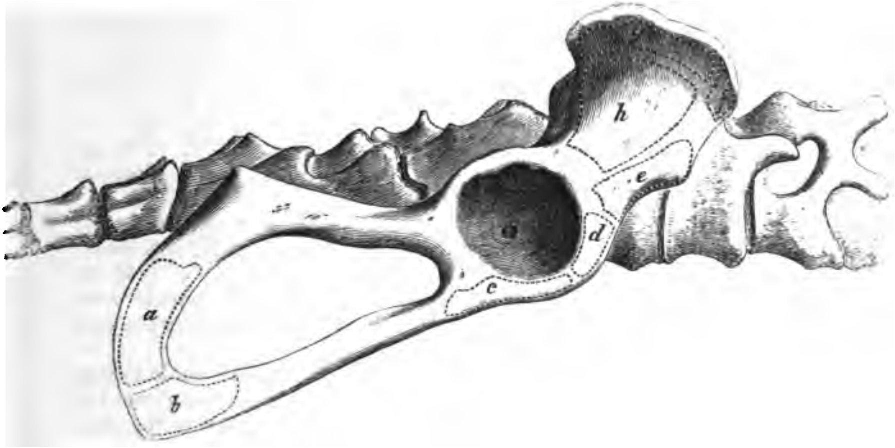
25. *Supinators* having origin from olecranon process . . . 0·55 oz.
viz.
1. *Extensor ossis metacarpi pollicis.*
2. *Extensor primi pollicis internodii.*

26. *Extensors* of wrist, having origin from the external condyle of the humerus, ... 0·40 oz.
viz.,
1. *Extensor carpi ulnaris.*
2. *Extensor digitorum communis.*
3. *Extensor minimi digiti.*

PART II.—MUSCLES OF THE POSTERIOR LIMBS.

1. *M. gracilis,* . . . . 1·88 oz.
Origin; from symphysis pubis (*vide* Fig. 18, *b*).
Insertion; whole length of side of tibia.

Fig. 18.



RIGHT SIDE OF THE PELVIS OF THE SEAL.

a, Origin of the *adductor solus.*
b, „ *gracilis.*
c, „ *pectinæus.*
d, „ *iliacus.*

e, Origin of the *rectus femoris.*
f, „ *sartorius.*
g, „ *glutæus medius.*
h, „ *glutæus minimus.*

2. *M. adductor solus,* . . . . 0·45 oz.

Origin; from $\frac{3}{4}$ in. behind symphysis pubis, for one inch along the ramus of the ischium (*vide* Fig. 18, *a*).

Insertion; if the tibia be divided into sixths, the insertion of this, the only adductor, is into the 2nd, 3rd, and 4th sixths reckoned from the top.

3. *M. pectinæus,* . . . . 0·09 oz.

The origin is shown in Fig. 18, *c*.

4. *M. iliacus,* . . . . 0·36 oz.

Origin; marked in Fig. 18, *d*.

Insertion; the inner condyle of the femur.

5. *M. quadriceps extensor femoris,* . . . . 1·15 oz.

Origin; the origin of the *rectus* is shown in Fig. 18, *e*.

6. *M. sartorius,* . . . . 0·15 oz.

Origin; shown in Fig. 18, *f*.

Insertion; inner side of the patella, and overlying the *rectus femoris.*

7. *M. tensor vaginæ femoris,* . . . . *not recorded.*

Origin; from the fascia covering the crest of the ilium, and overlying the *glutæus medius.*

Insertion; outer side of the patella.

8. *M. glutæus maximus,* . . . . 2·34 oz.

Insertion, into the great trochanter, whole outer side of femur, and top of fibula.

9. *M. glutæus medius,* including *pyriformis,* . . . . . . 0·48 oz.

Origin; marked at *g*, Fig. 18.

10. *M. glutæus minimus,* . . . . 0·45 oz.

Origin; marked at *h*, Fig. 18.

11. *M. agitator caudæ,* . . . . 0·98 oz.

Origin; first five caudal vertebræ.

Insertion; upper half of the tibia.

12. *M. obturator externus,* . . . . 1·02 oz.

13. *M. biceps femoris,* . . . . 0·45 oz.

Origin; *tuber ischii.*

Insertion; into the fascia covering the whole outer side of the leg, as in the Lion and other Carnivores; it is a triangular muscle.

14. *MM. semimembranosus et tendinosus,* . . . . 0·35 oz.

These muscles conjoined are represented by a single muscle, having its origin from the first caudal vertebra, and its insertion into the lower third of the *fibula.*[*]

Before describing the muscles of the leg, it is worth while to sum up the evidence for the assertion made at the commencement of this Paper, that the muscles of the posterior limb in the Seal differ from those of other Carnivores, principally in the shifting of their insertions to lower points on the leg.

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[*] It is to be observed that this muscle is inserted into the *fibula*, and not into the *tibia.*

Comparison of Insertion of Muscles in the Seal and Lion.

Muscle.	Point of Insertion.	
	Seal.	Lion.
1. *Adductor magnus*, .	Upper 2nd, 3rd, and 4th sixths of tibia, . . .	Whole length of back of femur.
2. *Iliacus*, ...	Inner condyle of femur, .	Lesser trochanter.
3. *Glutæus maximus*, .	Outer side of femur and top of fibula, ...	Along glutæal intertrochanteric ridge.
4. *Agitator caudæ*, . . .	Upper half of tibia, . . .	Outer side of patella.
5. *Semimembranosus et tendinosus*, . . .	Lower third of fibula, . .	Inner side of knee, and upper third of tibia.

15. *M. gastrocnemius*, ... 2·27 oz.

Origin; from the back of both condyles, and by means of fascia, from the heads of tibia and fibula, all round.

Insertion; *tendo Achillis.*

16. *M. tibialis posticus*, ... 0·20 oz.

Origin; from the back of the tibia, below the poplitæal line, and from the interosseous membrane.

Insertion; into the scaphoid bone, by tendon round inner ankle.

17. *M. flexor digitorum communis*, ... 2·03 oz.

Origin; from the whole length of the back of the fibula and interosseous membrane.

Insertion; by tendon passing round inner ankle, and afterwards distributed to toes.

18. *M. flexor hallucis*, ... 0·43 oz.

Origin; from the oblique poplitæal line on back of tibia and from the head of fibula.

Insertion; by tendon passing round inner ankle, into the tendon of the last; and dividing into branches to the toes which inosculate with those of the common flexor.

19. *M. poplitæus*, ... 0·18 oz.

20. *M. tibialis anticus*, ... 0·70 oz.

Insertion; by tendon in front of ankle, into the base and back of metatarsal of hallux.

21. *M. extensor hallucis*, ... 0·13 oz.

Origin; interosseous membrane, and inner edge of fibula.

Insertion; by tendon in front of ankle, into outer side of base of metatarsal of hallux.

22. *M. extensor digitorum communis = extensor medii digiti*, . 0·55 oz.

Origin; head of tibia, and head and upper third of fibula.

Insertion; by a tendon in front of ankle, into the distal end of the metatarsal of the middle toe.

[There is also a rudimentary *extensor brevis.*]

23. *M. peronæus longus,* . . . . 0·68 oz.

Origin; from external condyle of the femur, and by means of fascia, from the head of the fibula.

Insertion; by a tendon passing over the outer groove on the upper surface of the os calcis, and thence outwards, downwards, and inwards to the under sides of the tarsal ends of the 1st and 5th metatarsal bones.

This muscle assists the flexors in the feathering action of the great toe in swimming.

24. *M. peronæus brevis,* . . . . 0·56 oz.

Origin; outer side of fibula.

Insertion; by means of a tendon passing over the inner groove on the upper surface of the *os calcis,* and thence outwards and downwards to the outer side of the tarsal end of the 5th metatarsal bone.

The fibres of this muscle are blended with those of the *flexor digitorum communis;* and it acts as a pure abductor of the little toe, in the plane of the tibia and fibula.

PART III.—MUSCLES OF MASTICATION.

1. *M. digastricus,* . . . . 0·72 oz.
2. *M. massetericus externus,* . . . . 0·33 oz.

The external fibres are directed upwards and forwards.

3. *MM. temporalis et massetericus internus,*. . . . . 1·83 oz.

The temporal muscle cannot be separated from the internal fibres of the *masseter,* which are directed downwards, and somewhat backwards.

4. *M. pterygoideus internus,* . . . . 0·33 oz.

The fibres of this muscle are parallel to those of the external *masseter.*

5. *M. pterygoideus externus,* . . . . 0·03 oz.

XXVIII.—SOME REMARKS ON THE DOCTRINE OF CHARACTERISTIC FOSSILS.

By JOHN KELLY.

[Read before the Royal Geological Society of Ireland, November 9, 1864.]

IN treating of this subject, I shall begin with the Silurian Fossils. An endeavour has been made to arrange the fossils of the Silurian System in bands or zones, supposed to be parallel to the planes of stratification: that the lowest or oldest zones of the sequence contained peculiar fossils; the second, another suite, quite different; and so on with the third, fourth, and fifth zones.

Sir Roderick I. Murchison says, in his "Siluria," Ed. 1859:—"In the Appendix to the former edition of this work, the range of those species only which are common to the great divisions, Upper and Lower Silurian, was exhibited in a tabular form. I am now enabled to give a complete list, so far as our present knowledge extends, of all the species, and to particularize their occurrence in the subdivisions of the system."

The tabular form, so announced, is divided into six zones or columns:—

1. Lingula Flags,	4. Llandovery Rocks,
2. Llandilo Rocks,	5. Wenlock,
3. Caradoc or Bala,	6. Ludlow;

and in those six zones all the Silurian fossils are arranged, accordingly, in the book to which I have above alluded.

On inspecting the table, however, it will be seen that when the fossils were put into these columns, with, we may assume, every disposition both by the author and his *employés*, to keep them in their proper stalls, they often strayed away, and appeared in other stalls, where they had no right to be. One of them, *Stenopora fibrosa*, appeared in no less than five of the Silurian zones; thus, with others, breaking up the arrangement into zones as bands to which they should be confined. More of them had a like tendency. This arrangement does not stand the test of time and discovery. In Galway the Silurian rocks are seen to lie unconformably on the Primary, and this is perhaps the only district in the British Islands where the base of the Silurian rocks is well exhibited. This base is identified by a brown siliceous band of very hard sandstone, or rather quartz rock, without any fossil, about five chains or 330 feet thick, which is persistent for several miles through the country, and mostly affects a horizontal position. It is most important as a geological index in exploring the district. As before stated, this band lies unconformably on the grey mica slate, the yellow quartz rock, and the blue crystalline limestone of that district, as they happen to lie in succession under it, and in ascending it is succeeded conformably by the fossiliferous band, which appears to be about 200 to 300 feet thick. In this band the fossils occur in colonies, and not in zones, as tabulated in "Siluria." The most characteristic of those colonies are in the following localities:—

1. Bunowen, three miles from Leenane, on the Clifden road, where *Atrypa hemispherica* abounds in millions, in a calcareous grey grit, interstratified with conglomerate: six species altogether were obtained here, mostly Brachiopods.

2. Glencraff is three miles east of Bunowen, and in the hills two miles south of the Old Leenane Hotel. 15 species were found here, among which were 2 Trilobites, 6 Brachiopods, 2 Gasteropods, and 2 Cephalopods.

3. Moneenmore, half a mile N.E. of the Maum Hotel; high upon the side of the hill there is a rocky spot; in that there is especially one bed of grey calcareous grit, about 5 feet thick, in which 14 species were got, among which were 2 Trilobites, 2 Brachiopods, 5 Gasteropods, an Orthoceras, and *Bellerophon trilobatus*.

4. Boocaun, a mile west of the village of Fairhill. Here 23 species were found, consisting of 4 Trilobites, 3 Brachiopods, 6 Dimyaria and Monomyaria, 4 Gasteropods, 2 Bellerophons, 2 Orthoceratites.

5. Kilbride is three miles N. N. W. of Cong; it is a promontory which runs eastward into Lough Mask, and on the shore of that Lough is one

of the best localities I know to fill a bag of fossils, or ten bags. Here 40 species were obtained, among which were 14 Corals, 6 Trilobites, 17 Brachiopods, 1 Gasteropod, 1 Cephalopod.

6. Tonlegee is on the N. E. shoulder of Benlevy, a mountain six miles west of Cong. This mountain is 1375 feet high. There is no brown quartzite visible here, but a man can stand upon the junction of the crumpled layers of mica slate and the even-bedded layers of Silurian flags lying level and unconformably against them. The Fossils obtained here are included in the following Table, along with the others:—

ABSTRACT TABLE.

Locality.	Corals.	Trilobites.	Dimyaria.	Monomyaria.	Brachiopoda.	Gasteropoda.	Cephalopoda.	Heteropoda, and others.	Total.	Abundance of Fossils.
Bunowen, . .	..	..	..	..	5	..	1	..	6	Brachiopoda abundant.
Glencraff, . .	1	2	1	..	6	2	2	1	15	Middling.
Moneenmore,	..	2	1	1	2	5	1	4	14	Middling.
Boocaun, . .	..	4	2	4	8	4	2	..	23	Gasteropoda abundant.
Kilbride, . .	14	6	1	..	17	1	1	..	40	Corals abundant.
Tonlegee, . .	..	3	5	..	6	9	1	3	27	Middling.

It may be seen by inspection of this Table that some of those localities, and their groups of fossils, have no Corals—some others have more than one-third of the whole of the species found. At Bunowen, with its millions of Brachiopods, there was no Gasteropod. At Boocaun, Moneenmore, and Tonlegee there was no Coral found, but numerous Gasteropods. The fossiliferous appearance in a locality is not owing to variety, but to the great numerical preponderance of one or two kinds. A few other localities were examined, some of them very like one or other of those enumerated; for instance, Cappacorcogue, on the north shore of Lough Corrib, close to Cong, is similar to Bunowen in the millions of *Atrypa hemispherica* that prevail; and Shanballymore, two miles west of Outerard, the same. Ardaun, three miles S. W. of Cong, is most like Kilbride in the numbers of Corals, Brachiopods, and others that prevail in that locality.

I have gone thus perhaps rather far into detail, to show that in colonies or groups the fossils occur in the old rocks of the Galway district, like the oyster beds or cockle strands of recent times, and not in vertical zones, for there is but one fossiliferous zone in that country. Further information on this subject may be had in a paper on this district published in our "Journal," vol. viii., p. 251.

But Sir Roderick himself appears to have abandoned the subdivision of the Silurian series into zones founded on fossil evidence. In a pamphlet circulated by him at the meeting of the British Association at

Manchester in 1861, there are several passages which indicate this change of opinion. He first makes a *resumé* of the Primordial rocks of Barrande, in Bohemia; the same as made out by De Verneuil, in Spain; by James Hall, in the United States; by Sir William Logan, in Canada; and the Taconic System in North America; and compares all these with the Lower Silurian of the British Islands.

At p. 9 of this pamphlet some reasoning is given to show that the Fauna of the Silurian series should be separated from that of the Primordial zone, which stratigraphically constitutes its conformable base. He says:—"May we not, therefore, infer that in the sequel other fossil links similar to those which are now known to connect the Lower and Upper Silurian series, which I myself at one time supposed to be sharply separated by their organic remains, will be brought to light, and will then zoologically connect the primordial zone with the overlying strata into which it graduates?"

In this sentence Sir Roderick seems to be relaxing from the six zones. He once thought that the Lower and Upper Silurian zones were permanently distinct; but here he admits that other fossil links may appear similar to those which are now known to connect the Lower and Upper Silurian, "which he at one time thought to be sharply separated by their organic remains." He says again, at p. 11:—"A great revolution in the ideas of many an old geologist, including myself, has been effected. Strengthened and confirmed as my view has been by the concordant testimony of Ramsay, Harkness, Geikie, James, and others, I have no hesitation in considering a very large portion of the crystalline strata of the Highlands to be of the same age as some of the older fossiliferous Silurian rocks, whether in the form of slates in Wales, of graywacke schist in the southern counties of Scotland, or in the conditions of mud and sand at St. Petersburg."

Here is a graceful admission that he was once mistaken in his views of sharp lines separating the zones, in which he thought fossils of different kinds would be found. It is a worthy example to the positive dogmatical school, which sprang up from his teaching, and who still believe that Llandovery rocks can have no fossil in them but what is in his Table in "Siluria." Professor Sedgwick and himself are the geological labourers that did the greatest amount of field work of any two men now living in the British Islands; and if he, in his enthusiasm, made a few mistakes, and corrects them again, as he does here, posterity has no cause to complain.

Regarding Devonian fossils, the authors of the Devonian System say ("Trans. Geol. Soc.," second series, vol. iii., p. 690):—"Mr. Lonsdale, after an extensive examination of the fossils of South Devon, had pronounced them to form a group intermediate between those of the Carboniferous and Silurian systems;" and hence he concluded that the fossiliferous rocks of South Devon were subordinate to the Old Red Sandstone. This view could be effectually maintained only by one who knew the fossils of the Silurian system." As well as the authors of the Devonian system, Dr. Buckland adopted this conclusion, as stated in one of his presidential addresses ("Proceedings of the Geological Society," vol. viii., p. 225), and it may be said to have been adopted by the geologists of England generally. This deduction of Mr. Lonsdale's was made upon the assumption that all the fossils of the Silurian and Carboniferous systems were known at that time; for he says, at p. 726—" Until the organic remains of the Mountain Limestone and of the Silurian system had been determined, it was vain to speculate on the age of a series of fossils procured from a region but partially examined, beset with faults, and traversed by igneous rocks." It has turned out that it was premature to assume that all the fossils of both systems were then known; for since that time, 1839, Mr. Frederick M'Coy has described 442 new species discovered in Ireland belonging to the Carboniferous rocks, and 82 new Silurian species, in two synopses, printed by Sir R. Griffith in 1844 and 1846. Beside this, Gen. Portlock has added 71 species to the Carboniferous, and 105 to the Silurian; and Major Austin 22 new species to the Carboniferous rocks—in all, 722 new species in the Irish rocks; and no doubt hundreds are yet unknown in both systems. Looking closely into this conclusion of Mr. Lonsdale's, that the South Devon fossils formed a group intermediate between those of the Carboniferous and Silurian systems, there appears to be something wanting. The reasoning seems to be defective. How could any one fossil be intermediate between two others of different kinds? and how could forty Devonian fossils be intermediate between forty of the Silurian and forty of the Carboniferous? If a cockle and an oyster could produce a hybrid animal, that might be an intermediate species, if it had the power of reproduction; but so long as the new-born animal is a cockle, or an oyster, it is not intermediate. It appears, therefore, that the intermediate character given to the Devonian fossils is an absurdity, since they are not either mules nor other hybrids. Part of the Devonian fossils are *common* to both the other adjacent systems, according to my views. They are intermediate, which, I suppose, means *not common*, by Mr. Lonsdale's. It appears to me that this conclusion, so much applauded by learned men, does not bear examination, in the sense in which it was received and adopted. On the principle that certain fossils occur only in particular formations or zones, it has been supposed that the fossils found in the rocks of Devonshire are peculiar to that country, and that the fossils found in the Carboniferous rocks of Ireland are peculiar to that system; but I hope to be able to show that this is not the case, and that many of the Devonian fossils are found in that system in the succession which lies over that series, and some of them in the formation which lies under it; that, in fact, the same fossil sometimes runs through three geological formations. That many of the fossils found in Devonshire and Cornwall, and described in 1841 in "Phillips's Palæozoic Fossils," occur also in the Carboniferous system of Ireland, was first made known by M'Coy, and published in the Synopsis of the Carboniferous Fossils of Ireland, printed by Sir Richard Griffith in 1844. This could scarcely be believed by those who hold to the infallibility of fossils as a test of the age of the rocks in which they are found; and M'Coy, who first laid open this broad fact, laid himself open to much unmerited censure and aspersion on his labours on account of the discovery. I have heard it said by palæontologists of the present day that he identified the fossils in Sir Richard Griffith's collection erroneously; that this is the reason why a large proportion of the Devonian fossils were supposed by him to be the same as those of the Carboniferous Limestone, and that the fault in question lies with M'Coy, and not with the fossils.

These aspersions appear to have been made by these gentlemen in order to maintain their own views in opposition to M'Coy's results. It is easy, when a man wishes to have a geological fact settled his own way, to cast aspersions on the labours of one who may differ from him in opinion; but it is not so easy in a disputed point to make people believe that he who casts the aspersions is right, and his opponent wrong. Besides the new species described, Mr. M'Coy examined and named many thousands of specimens of Palæozoic fossils in Sir Richard Griffith's collection; he did the same in Professor Sedgwick's collection in the Cambridge Museum. I assisted him in writing the names as he read them off from the Irish specimens, and whenever a specimen was doubtful, he laid it aside for further examination, so cautious was he in this work.

I heard Mr. Salter, a very competent authority, who examined Sir Richard Griffith's collection, afterwards say that M'Coy should not be vilified; that he was a good naturalist, and had a sharp, correct eye. For my own part, I had good opportunities of knowing him, and I always looked upon him as far superior to many who unjustly censured him. He may have made some mistakes. Fossils are often so much crushed or contorted, that it is difficult to know their forms; but I will venture to say, that out of the 440 new fossils of the Irish Carboniferous rocks that he named, not ten, or perhaps five per cent. of them will ever be altered for the better. As for those known before, and figured by Sowerby, Phillips, or Lonsdale, I believe they are all correctly named, and those found in Ireland were all in Sir Richard Griffith's collection in 1842.

In 1853, at the Great Exhibition in Dublin, the whole of this collection was removed to the Exhibition Rooms. In several localities in the North and West of Ireland, some of the most beautiful of the fossils were found in a very soft, black fine-grained shale, as easily disintegrated by exposure to the atmosphere as any of the soft black shales in the Coal Measures. In a dry cabinet this shale might last a few years; but at the time I mention the collection having been moved from Sir Richard Griffith's house to the Exhibition, these tender shales did not bear the agitation of carriage, and many of them crumbled away, and were lost. In 1857, at the meeting of the British Association, many gentlemen visited the collection, and did not find there, of course, all the species described in the Synopsis. I fear this fact led to the depreciation of the character of the cabinet, and perhaps gave rise to the charge of erroneous identification made against Mr. M'Coy.

Some time ago, Mr. Thomas Davidson, the eminent palæontologist, sent me a list, in which he stated that seventy of the species recorded in the *Synopsis* were not seen by him in any collection in England or Scotland that came under his notice, and were therefore not proven. He was perfectly right in saying they were not proven to him, if he did not see them.

The Carboniferous Slate, or Lower Limestone Shale (for it goes by those two names), contains many of the disputed seventy fossils. In several localities in the North and West of Ireland they occur in this band. Those seventy disputed fossils are Devonian, and it so happens are also in this band, belonging to the Carboniferous system. About twenty species of them were obtained from the soft black shale which occurs at the base of the limestone at Lisnapaste, a locality five miles south of the town of Donegal. Those having been obtained from that perishable black shale are lost, and they cannot be seen again, without a visit to the place, or getting up a few boxes of fresh specimens from it. The little bridge south of the village of Ballynakillew is on this black shale, and the banks of streams and road-cuttings adjacent afford a profusion of the fossils. There are also other localities in which some of the fossils not proven were obtained, as at Bruckless, twelve miles west of Donegal; Bundoran, three miles west of Ballyshannon; Larganmore, two miles east of Bangor, in Mayo; and a few other places.

This subject, showing that the same fossils often occur in the Silurian, Devonian, and Carboniferous rocks, may be best studied in Murchison's "Silurian System;" in Phillips's "Palæozoic Fossils," and in M'Coy's "Synopsis of the Carboniferous Fossils of Ireland." By the help of these works comparisons may be made, and results obtained highly interesting in the pursuit of geology.

The following Table has been made from lists given by Sir Henry De la Beche, in the "Memoirs of the Geological Survey of Great Britain." In a Table so made out, the name of every fossil is a fact, and may at once be controverted if it be wrong. He gives lists of the fossils obtained at three localities of the Devonian country: at Pilton, on the west coast of North Devon, at vol. i., p. 73; at Petherwin, in Cornwall, at p. 80, and at Newtownbushel, in South Devon, at p. 88. In the Table will be found the names of the several fossils, recorded by him, as obtained from those three localities of Devon and Cornwall. In the first column are those got at Pilton; in the second, those got at Petherwin; and in the third, those got at Newtownbushel, the latter by Mr. G. Austen. In the fourth column the Silurian Fossils are marked, and the fifth has a star opposite every fossil of those which has been found in the Irish Carboniferous System, and recorded in the Synopsis, with the name of a locality in which it has been found, upon my own authority. Moreover, no new name, nor any name has been introduced into this Table, but Sowerby's, Phillips's, and other old names, which have not been disputed; only this, that the Irish Fossils have been taken at M'Coy's interpretation, which I believe to be correct.

TABLE.

Names of Fossils.	Pilton.	Petherwin.	Newtonbushel.	Silurian.	Carboniferous.	Irish Localities.
Turbinolopsis Celtica, . .	*	*	. .	. .	*	Ballinglen, Ballycastle (Mayo).
,, pluriradialis,	*	. .	. .	. .	*	Currens, Tralee.
Manon cribrosum, . . .	*	. .	. .	. .	*	Hook Point, Wexford.
Millepora gracilis, . . .	*	. .	. .	. .	*	Ballintrillick, Bundoran.
Glauconome bipinnata,. .	*	. .	. .	. .	*	Blacklion, Enniskillen.
Fenestella laxa, ...	*	*	. .	. .	*	,, ,,
,, antiqua, . . .	*	*	*	*	* *	Currens, Tralee.
Pentremites ovalis, . . .	*	. .	. .	. .	*	Ireland (M'Coy) Morris.
Cyathocrinus macrodactylus, ...	*	. .	. .	. .	. .	
Adelocrinus hystrix,. . .	*	. .	. .	. .	*	Ballinacourty, Dungarvan.
Actinocrinus tenuistriatus,	*	. .	. .	. .	*	Carrownanalt, Keadue.
Cyathocrinus pinnatus, .	*	. .	. .	. .	*	Larganmore, Bangor (Mayo).
,, variabilis, .	*	. .	. .	. .	*	Larganmore, Bangor.
Sanguinolaria lyrata, . .	*	. .	. .	. .	*	Ireland (Sow.).
Pullastra antiqua, . . .	*	*	. .	. .	. .	
,, complanata, . .	*	. .	. .	*	. .	
Cypricardia impressa, . .	*	*	. .	*	. .	
Nucula plicata,.	*	. .	. .	. .	. .	
,, lineata,.	*	. .	. .	. .	*	Lisnapaste, Donegal.
,, latissima,. . . .	*	. .	. .	. .	. .	
Cucullæa amygdalina, . .	*	. .	. .	. .	. .	
,, Hardingii, . .	*	. .	. .	. .	. .	
,, angusta, . . .	*	. .	. .	. .	. .	
,, unilateralis, . .	*	. .	. .	. .	. .	
,, trapezium, . .	*	. .	. .	. .	. .	
Pecten polytrichus, . . .	*	. .	. .	. .	*	Ballintrillick, Bundoran.
,, transversus, . . .	*	*	. .	. .	*	Clonea, Dungarvan.
Avicula cancellata, . . .	*	. .	. .	. .	. .	
,, rudis, ...	*	. .	. .	. .	. .	
,, Damnoniensis, .	*	. .	. .	. .	. .	
Leptæna analoga, . . .	*	. .	. .	. .	*	Currens, Tralee.
,, convoluta, . . .	*	. .	. .	. .	*	Hook, Wexford.
,, scabricula, . . .	*	. .	. .	. .	*	Millicent, Kildare.
,, caperata, . . .	*	*	. .	. .	*	Hook, Wexford.
,, membranacea, .	*	*	. .	. .	*	Lisnapaste, Donegal.
Orthis interlineata, . . .	*	*	. .	. .	*	Currens, Tralee.
,, plicata, ...	*	. .	. .	. .	*	Lisnapaste, Donegal.
,, parallela, ...	*	*	. .	. .	*	,, ,,
,, compressa, . . .	*	. .	. .	*	*	Castle Espie, Co. Down.
,, calcar, ...	*	. .	. .	. .	. .	
,, semicircularis, . .	*	. .		*	* *	Currens, Tralee.
Spirifer microgemma, . .	*	. .	*	. .	*	Hook, Wexford.
,, unguiculus, . . .	*	*	*	. .	*	Poulscadden, Howth.

Names of Fossils.	Pilton.	Petherwin.	Newtonbushel.	Silurian.	Carboniferous.	Irish Localities.
Spirifer decussata, . . .	*	*	..	..	*	Lisnapaste, Donegal.
„ calcarata, . . .	*	*	..	..	*	Millicent, Kildare.
„ disjuncta, . . .	*	*	..	..	*	Currens, Tralee.
„ obliterata, . . .	*	..	..	..	..	
„ rudis, ...	*	..	..	..	*	Howth, Dublin.
„ mesomala, . . .	*	..	..	..	*	Irish locality lost.
„ megaloba, . . .	*	..	..	..	*	Poulscadden, Howth,
Terebratula laticosta, . .	*	..	..	..	*	Rahoran, Fivemiletown.
„ pleurodon, . . .	*	*	..	..	* *	Millicent, Kildare.
Acroculia vetusta, . . .	*	..	*	*	*	„ „
Euomphalus serpens, . .	*	*	..	..	*	Oldtown, Co. Dublin; Howth.
Natica meridionalis,. . .	*	..	..	..	..	
Pleurotomaria cancellata,	*	*	..	..	..	
„ aspera, . .	*	*	*	..	..	Newton (Morris)..
„ expansa, .	*	..	..	..	*	Bolland (Morris).
„ gracilis,. .	*	..	..	..	..	
Loxonema rugifera, . . .	*	..	..	..	*	Otterburne, Northumberland (Phil.).
Murchisonia angulata, . .	*	*	..	..	*	Bolland (Phil.).
Macrocheilus neglectus, .	*	..	..	..	..	
Bellerophon Urii, ...	*	..	..	*	*	Cookstown, Tyrone (Sil. Mor.).
„ trilobatus, .	*	*	..	*	..	
„ globatus, . .	*	..	..	*	*	Derryloran, Cookstown.
Orthoceras Ludense, . .	*	..	...	*	..	
„ imbricatum, .	*	..	..	*	..	
„ lineolatum,. .	*	..	..	..	*	Doneraile, Cork.
„ tentaculare, .	*	..	..	..	..	
Calymene accipitrina, . .	*	..	..	..	..	
„ lævis, ...	*	..	*	..	*	Clonea, Dungarvan (Morris).
Terebratula acuminata. .	*	..	..	..	*	Millicent, Kildare.
Atrypa oblonga, ...	*	..	..	..	*	Clonea, Dungarvan.
„ indentata, . . .	*	..	..	..	*	Lisnapaste, Donegal (common).
„ striatula, . . .	*	..	..	..	*	Clonea, Dungarvan.
Leptæna prælonga, . . .	*	..	..	..	*	Lisnapaste (Donegal).
Spirifera extensa, . . .	*	*	..	..	*	Currens, Tralee (Peth. Morris).
Avicula pectinoides,. . .	*	..	..	..	..	
Pecten nexilis, ...	*	..	..	..	..	
„ arenosus, ...	*	..	..	..	*	Millicent, Kildare.
Turbinolopsis Celtica, . .	*	*	..		*	Ballinglen, Mayo.
Amplexus tortuosus, . .	..	*	*	..	*	Ballyduff, Dungarvan.
Cyathophyllum cæspitosum, ...	..	*	..	*	..	
Fenestella laxa, ...	*	*	..	..	*	Blacklion, Enniskillen.
„ antiqua, . . .	*	*	..	..	*	Currens, Tralee.

Names of Fossils.	Pilton.	Petherwin.	Newtonbushel.	Silurian.	Carboniferous.	Irish Localities.
Cyathocrinus variabilis, .	..	*	..	..	* *	Ballintrillick, Bundoran.
„ ellipticus, .	..	*	..	..	*	Carrownanalt, Keadue.
Sanguinolaria sulcata, .	..	*	..	..	*	Hook, Wexford.
Pullastra antiqua, . . .	*	*	..	..	..	
Cypricardia semisulcata, .	..	*	..	*	..	
„ impressa, .	*	*	..	*	..	
„ deltoidea, . .	..	*	..	..	*	Clogher (Portlock).
Modiola amygdalina, . .	..	*	..	..	*	Larganmore, Mayo.
Pecten granulosus, . . .	*	*	..	..	*	Carrownanalt, Keadue.
„ transversus, . .	*	*	..	..	..	
„ alternatus, . . .	..	*	..	..	..	
„ arachnoides, . .	..	*	..	..	*	Ballinacourty, Dungarvan.
Pterinea ventricosa, . . .	..	*	..	*	..	(Sil., Sharpe).
Avicula subradiata, . .	..	*	..	..	..	
„ exarata, ...	..	*	..	..	..	
Leptæna caperata, . . .	*	*	..	..	*	Currens, Tralee.
„ laxispina, . . .	..	*	..	..	*	Salmon, Dublin.
„ fragaria, . . .	..	*	*	..	*	Poulscadden, Howth.
„ membranacea, .	*	*	..	..	*	Lisnapaste, Donegal.
Orthis interlineata, . . .	*	*	..	..	*	Currens, Tralee.
„ parallela, ...	*	*	..	..	*	Lisnapaste, Donegal.
Spirifer protensa, ...	..	*	..	..	..	
„ unguiculus, . . .	*	*	*	..	*	Poulscadden, Howth.
„ lineata, ...	..	*	..	..	*	Millicent, Kildare.
„ decussata, . . .	*	*	..	..	*	Lisnapaste, Donegal.
„ calcarata, . . .	*	*	..	..	*	Millicent, Kildare.
„ disjuncta, . . .	*	*	..	..	*	Currens, Tralee.
„ gigantea, . . .	..	*	..	..	*	Bundoran, Ballyshannon.
„ grandæva, . .	..	*	..	..	*	Currens, Tralee.
Atrypa desquamata, . .	..	*	..	..	*	Ballinacourty, Dungarvan.
Terebratula pleurodon, .	*	*	..	..	* *	Millicent, Kildare.
„ subdentata, .	..	*	..	..	..	
Euomphalus serpens, . .	*	*	..	..	*	Oldtown, Dublin.
Natica nexicosta, ...	..	*	..	..	..	
Pleurotomaria cancellata,	*	*	..	..	..	
„ antitorquata,	..	*	*	..	..	
„ aspera, . .	*	*	..	..	..	
Loxonema sinuosa, . . .	..	*	..	*	..	
„ nexilis, . . .	..	*	*	..	..	
„ tumida, . . .	..	*	..	..	*	Bruckless, Donegal.
Murchisonia angulata, .	*	*	..	..	*	(Bolland Phillips).
Bellerophon trilobatus, .	*	*	..	*	..	
„ hiulcus, . .	..	*	..	..	* *	Ardclogh, Kildare.
Orthoceras cinctum, . .	..	*	*	..	*	Rathgillen, Nobber.
„ laterale, . . .	..	*	..	..	*	Millicent, Kildare.
„ Ludense, . .	..	*	..	*	..	
„ ibex, ...	..	*	..	*	..	

Names of Fossils.	Pilton.	Petherwin.	Newtonbushel.	Silurian.	Carboniferous.	Irish Localities.
Orthoceras striatulum,	. .	*	. .	. .	. .	
Cyrtoceras rusticum,	. .	*	*	. .	. .	
Nautilus megasiphus,	. .	*	. .	. .	. .	
Goniatites insignis,	. .	*	. .	. .	. .	
,, linearis,	. .	*	. .	. .	. .	
,, biferus,	. .	*	. .	. .	. .	
Clymenia levigata,	. .	*	. .	. .	. .	
,, striata,	. .	*	. .	. .	. .	
,, linearis,	. .	*	. .	. .	. .	
,, fasciata,	. .	*	. .	. .	. .	
,, sagittalis,	. .	*	. .	. .	*	Bruckless, Donegal.
,, plurisepta,	. .	*	. .	. .	*	,, ,,
,, valida,	. .	*	. .	. .	. .	
,, granulata,	. .	*	. .	. .	*	Clonea, Dungarvan.
Spirifera extensa,	. .	*	. .	.	*	Currens, Tralee (Morris).
Terebratula hispida,	. .	*	. .	. .	*	Kildress, Cookstown.
,, indentata,	*	*	. .	. .	*	Larganmore, Mayo (N. Dev., Morris).
,, triangularis,	. .	*	. .	. .	. .	
,, striatula,	. .	*	. .	. .	*	Clonea, Dungarvan.
,, fallax,	. .	*	. .	. .	* *	Bruckless, Donegal.
Brontes flabellifer,	. .	. .	*	. .	. .	
Calymene Latreillii,	. .	. .	*	. .	*	Clonea, Dungarvan.
,, Sternbergii,	*	. .	*	. .	. .	Pilton (Morris).
Orthoceras cinctum,	. .	*	*	. .	. .	Silurian (Morris).
,, ellipsoideum,	. .	. .	*	. .	. .	
,, pyriforme,	. .	. .	*	*	. .	Silurian (Morris).
,, tubicinella,	. .	. .	*	. .	. .	
,, ventricosum,	. .	. .	*	. .	. .	
Cyrtoceras armatum,	. .	. .	*	. .	. .	
,, fimbriatum,	. .	. .	*	. .	. .	
,, marginale,	. .	. .	*	. .	. .	
,, nautiloideum,	. .	. .	*	. .	. .	
,, nodosum,	. .	. .	*	. .	. .	
,, obliquatum,	. .	. .	*	. .	. .	
,, ornatum,	. .	. .	*	. .	. .	
,, quindecimale,	. .	. .	*	. .	. .	
,, reticulatum,	. .	. .	*	. .	. .	
,, rusticum,	. .	*	*	. .	. .	
,, tridecimale,	. .	. .	*	. .	. .	
Nautilus germanus,	. .	. .	*	. .	. .	
Goniatites excavatus,	. .	. .	*	. .	*	Blacklion.
,, globatus,	. .	. .	*	. .	. .	
,, serpentinus,	. .	. .	*	. .	*	Carrownanalt, Co. Rosc.
,, transitorius,	. .	. .	*	. .	. .	
Bellerophon hiulcus,	. .	*	*	. .	*	Yealmbridge (Mor.)
,, striatus,	. .	. .	*	. .	*	Ardclogh, Carluke (Mor)
,, Wenlockensis,	. .	. . .	*	*	*	Ballinglen, Ballycastle, Mayo.
,, Woodwardii,	. .	. .	*	. .	*	Bolland (Morris).

Names of Fossils.	Pilton.	Petherwin.	Newtonbushel.	Silurian.	Carboniferous.	Irish Localities.
Buccinum acutum,	..	..	*	..	*	Millicent, Kildare.
,, annulatum,	..	..	*	..	..	Macr. Schlotheimii (Morris).
,, imbricatum,	..	..	*	..	*	Millicent, Kildare.
,, spinosum,	..	..	*	..	*	Whitewell (Phil.).
Murex harpula,	..	..	*	..	..	
Pleurotomaria antitorquata,	..	*	*	..	..	Petherwin (Morris).
,, aspera,	..	*	*	..	..	,, ,,
,, cancellata,	..	*	*	..	..	,, ,,
,, impendens,	..	..	*	..	..	
,, monilifera,	..	..	*	..	*	(Bolland, Morris).
Schizostoma tricincta,	..	..	*	..	..	
Macrocheilus elongatus,	..	..	*	..	..	
Terebra Hennahii (Sow.),	..	..	*	..	..	Hen. (Phil.)
,, nexilis,	..	*	*	..	..	Lox. nex. (Mor.)
Turritella abbreviata,	..	..	*	..	..	
Loxonema reticulata,	..	..	*	..	..	
,, cincta,	..	..	*	..	..	
Turbo textatus,	..	..	*	..	..	
Euomphalus annulatus,	..	..	*	..	..	
,, circularis,	..	..	*	..	..	
,, radiatus,	..	..	*	..	..	
,, serpens,	*	*	*	..	*	Oldtown, Co. Dublin; Howth.
Nerita spirata,	..	..	*	*	*	Horath, Co. Meath.
Pileopsis vetusta,	..	..	*	..	*	Millicent, Kildare.
Pleurorhynchus aliformis,	..	..	*	..	*	Malahide, Dublin.
,, minax,	..	..	*	..	*	Howth, Dublin.
Modiola scalaris,	..	..	*	..	*	Larganmore, Mayo.
Mytilus Damnoniensis,	..	..	*	..	..	
Megalodon carinatus,	..	..	*	..	..	
,, cucullatus,	..	..	*	..	..	
Pterinea radiata,	..	..	*	..	..	
Avicula texturata,	..	..	*	..	*	Clonea, Dungarvan.
,, reticulata,	..	..	*	.	..	
Pecten plicatus,	..	..	*	..	*	Ballyduff, Dungarvan.
Leptæna fragaria,	..	..	*	..	..	
,, nodulosa,	..	..	*	..	*	Currens, Tralee.
,, rugosa,	..	..	*	..	*	Millicent, Kildare (= P. analoga).
Orthis arachnoidea,	..	..	*	..	*	Millicent, Kildare.
,, arcuata,	..	..	*	..	*	Toberelathan, Loughrea.
,, crenistria,	..	..	*	..	*	Bundoran, Ballyshannon.
,, granulosa,	..	..	*	..	* *	Howth, Dublin.
,, Hardrensis,	..	..	*	..	* *	Ballyduff, Dungarvan.
,, interstrialis,	..	..	*	..	..	
,, resupinata,	..	..	*	..	* *	Bundoran, Ballyshannon.

Names of Fossils.	Pilton.	Petherwin.	Newtonbushel.	Silurian.	Carboniferous.	Irish Localities.
Orthis lenis, ...	. .	. .	*	. .	. .	
Spirifer cuspidata, . .	. .	. .	*	. .	* *	Millicent, Kildare.
,, distans, . . .	. .	. .	*	. .	*	,, ,,
,, hirundo, . . .	. .	. .	*	. .	. .	
,, microgemma, .	. .	. .	*	. .	. .	
,, nudus, ...	. .	. .	*	. .	*	Clonea, Dungarvan.
,, heteroclitus, . .	. .	. .	*	. .	. .	
,, oblatus, . . .	. .	. .	*	. .	* *	Millicent, Kildare.
,, plebeia, . . .	. .	. .	*	. .	* *	,, ,,
,, phalæna, . . .	. .	. .	*	. .	*	St. Doulough's, Dublin.
,, simplex, . . .	. .	. .	*	. .	*	Malahide, Dublin.
,, subconicus, . .	. .	. .	*	. .	*	Bundoran, Ballyshannon.
,, speciosus, . . .	. .	. .	*	. .	*	,, ,,
,, unguiculus, . .	*	*	*	. .	*	Lisnapaste, Donegal; Howth.
Stringocephalus Burtini, .	. .	. .	*	. .	. .	
Terebratula acuminata, .	. .	. .	*	. .	* *	Millicent, Kildare.
,, anisodonta, .	. .	. .	*	. .	*	Rahoran, Fivemiletown.
,, aspera, . .	. .	. .	*	*	*	Poulscadden, Howth.
,, bifera, . .	. .	. .	*	. .	*	Millicent, Kildare.
,, cassidea, .	. .	. .	*	. .	. .	
,, comta, . .	. .	. .	*	. .	*	Ballinglen, Ballycastle, Mayo.
Atrypa crenulata, . . .	. .	. .	*	. .	. .	
,, cuboides, . . .	. .	. .	*	. .	. .	
,, desquamata, . .	. .	. .	*	. .	*	Clonea, Dungarvan.
Terebratula ferita, . .	. .	. .	*	. .	*	Millicent, Kildare.
,, flexistria, .	. .	. .	*	. .	*	,, ,,
,, galeata, . .	. .	. .	*	. .	. .	
,, hastata, . .	. .	. .	*	. .	* *	,, ,,
,, juvenis, . .	. .	. .	*	. .	*	Bruckless, Donegal.
,, Mantiæ, . .	. .	. .	*	. .	*	Ireland (Sowerby's authority).
,, prisca, . .	. .	. .	*	. .	*	Shanbally, Cork.
,, proboscidalis,	. .	. .	*	. .		
,, pleurodon, .	. .	. .	*	. .	* *	Millicent, Kildare.
,, pugnus, . .	. .	. .	*	. .	* *	,, ,,
,, reniformis, .	. .	. .	*	. .	* *	,, ,,
,, rhomboidea,	. .	. .	*	. .	*	Howth, Dublin.
,, sacculus, . .	. .	. .	*	. .	* *	Millicent, Kildare.
,, Wilsoni, , .	. .	. .	*	*	. .	Sil. (Mor.).
Cyathocrinites geometricus,	. .	. .	*	. .	*	Currens, Tralee.
,, nodulosus, .	. .	. .	*	. .	. .	
Actinocrinites triacontadactylus, . . .	. .	. .	*	. .	*	Manorhamilton, Leitrim.
Platycrinites interscapularis,	. .	. .	*	. .	*	Howth, Dublin.
,, pentangularis,	. .	. .	*	. .		

Names of Fossils.	Pilton.	Petherwin.	Newtonbushel.	Silurian.	Carboniferous.	Irish Localities.
Platycrinites tuberculatus, .	. .	. .	*	. .	*	Ballinacourty, Dungarvan.
Sphæronites tesselatus,	. .	. .	*	. .	. .	
Stromatopora concentrica,	. .	. .	*	*	*	Howth, Dublin.
,, polymorpha,	. .	. .	*	*	*	Curkeen, Skerries; Dublin. (Sil. Portl.).
Fenestella abuormis, . .	. .	. .	*	. .	. .	
,, antiqna, . . .	*	*	*	*	*	Currens, Tralee. (Sil. Lons.).
Retepora infundibulum, .	. .	. .	*	*	. .	(Sil. Mor.).
,, prisca, ...	. .	. .	*	. .	*	Hook Head, Wexford.
Lithodendron cæspitosum,	. .	. .	*	. .	*	Millicent, Kildare.
Amplexus tortuosus, . .	. .	*	*	. .	*	Ballyduff, Dungarvan.
Cyathophyllum turbinatum, ...	. .	. .	*	*	* *	Benburb, Armagh.
Cystiphyllum Damnoniense,	. .	. .	*	. .	. .	
,, vesiculosum,	. .	. .	*	. .	. .	
Strombodes vermicularis, .	. .	. .	*	. .	*	Benburb, Armagh (Portlock).
Astræa ananas, ...	. .	. .	*	*	. .	(Sil. Mor.).
,, helianthoides, . .	. .	. .	*	. .	. .	
,, Hennahii, . . .	. .	. .	*	. .	. .	
,, pentagona, . . .	. .	. .	*	. .	*	Larganmore, Bangor; Mayo.
Porites pyriformis, . . .	. .	. .	*	*	. .	
Coscinopora placenta, . .	. .	. .	*	. .	. .	Irish locality lost.
Favosites fibrosa, ...	. .	. .	*	*	* *	Killymeal, Dungannon.
,, Gothlandica, .	. .	. .	*	*	*	St. John's Point, Donegal.
,, polymorpha, . .	. .	. .	*	*	*	Hook, Wexford.
,, spongites, . . .	. .	. .	*	*	* *	Millicent, Kildare.

From this Table may be seen the following results:—

	Total.	Silurian.	Carboniferous.
From Pilton, ...	80	11	53
,, Petherwin, ...	72	8	40
,, Newtonbushel, . . .	139	16	71
Total, . . .	291	35	164
Take, . . .	22		22 repeated.
Remains, . .	269		142

Thus it appears that of the whole number of fossils, 269, found in the three Devonian localities, more than half, or 142 of them, occur in the Carboniferous Limestone of Ireland, and 35 of the species are also noted as belonging to the Silurian rocks. Again, 21 species out of 152 are common to Pilton and Petherwin; 11 species out of 211 are common to Petherwin and Newton; and 6 species out of 219 are common to Pilton and Newton. Upon comparing those localities and their numbers, there appears another remarkable result, that there are far more species in any one of the above three Devonian localities common with those of the Irish limestone than there are found in any one of them compared with any other, although the whole three are in the Devonian country.

This result, so far, goes to establish the opinion that the fossils of Devonshire and Cornwall occur in colonies, like those of the Silurian rocks in Galway. A general result, very similar to that obtained from this table, may be seen by analyzing the table given in Phillips's "Palæozoic Fossils," at p. 142. That table gives 277 species got in Devonshire and Cornwall in all the localities examined, and out of those 133 occur in the Carboniferous system. This table, like that made from De la Beche's lists, shows that about half the fossils of Devonshire and Cornwall occur in the Carboniferous Limestone of Ireland—the other half in the Devonian and Silurian formations.

The comparison of the fossils of the Devonian rocks with those of the Carboniferous system is remarkable, in so far that, if fossils were to be the guide, it would lead one to suppose that the whole of the rocks in both belonged to one system. This, however, is disproved by a physical unconformity which occurs between them, where the two are in contact. This is not seen in the South of Ireland, where, like Devonshire, neither the bottom nor the top of the Devonian rocks is visible; but it may be traced in the North, along the S. E. border of the Tyrone Devonian group; at Ballyreagh, to the east of Ballygawley; about Aghnaglogh, one mile N. W. of Clogher; and in the valley of the Tempo River, near Lisbellaw. In those places unconformable junctions may be seen between the two systems. So far as fossils go, Devonshire has enough of peculiar fossils to establish its claim as a subdivision of the transition rocks; it has five species of Cucullæa from Marwood, seven species of Clymenia from Petherwin, and eleven species of Cyrtoceras from Newton. Along with these, there are 88 other Devonian species, in the tables in Phillips's "Palæozoic Fossils," in all 111 published, none of which were yet found in the Irish Carboniferous rocks.

I lately heard a letter read from a palæontologist, in which he stated that the correct succession of the rocks was now only to be determined by the palæontologist. This appears to be going too far; it is putting the accessory before the principal; or, as better expressed in vulgar *parlance*, putting the car before the horse. My views on the use of fossils in geology are these:—That the first of all things to be considered is the physical succession of sedimentary systems, groups, and beds; the lowest known in the foundations of the earth to be the first in the classification; the uppermost to be the last, and so on with all between those; and next, as is shown by the community of fossils between the Devonian and Carboniferous groups, just discussed, that fossils should have only a secondary influence in determining the age of a group of rocks. Stress has been laid on mineral character and colour; but these are points that cannot be pressed in this matter.

I shall conclude by stating that the views I entertain on this subject are so fully and so clearly expressed in an article in the "Edinburgh Review" for April, 1841, that I shall quote it. The reviewer says of the geologist:—"His primary and essential business is more allied to that of the physical geographer and topographic engineer than of the naturalist. His object is to ascertain the mineral structure of the earth; and interesting and delightful as are the inquiries connected with the study of fossils, the geologist employs his natural history in the first instance as an instrument of stratigraphical arrangement and identification. We should be sorry to be misunderstood upon this point, or to be supposed either to undervalue or to depreciate the importance of palæontology to the science of the earth; but it is only a department, which can never supplant or supply the primary and essential necessity for physical, geometrical, and mineralogical research; and it may be useful to state thus distinctly what appears to us to be the correct view of this matter, as the fashion of the day seems to run in an opposite direction, and to give an undue proportionate value to the study of fossils alone."

XXIX.—On the Geology of the New Zealand Gold-fields.* By W. Lauder Lindsay, M. D., F. R. S. Edin., &c., &c.; Honorary Fellow of the Philosophical Institute of Canterbury, New Zealand.

[Read before the Royal Geological Society of Ireland, January 11, 1865.]

In the following Paper I do not aim at a topographico-geological description of *all* the New Zealand Gold-fields, which are now very numerous, and may be said to extend, with intervals, from the extreme north of the North Island to the south of the Middle Island. Such a description would, from the varying character of these Gold-fields, occupy a bulk which I do not propose, at present at least, to devote to the subject. My present object is simply to give a general idea or sketch of the geological character of the New Zealand Gold-fields. For this purpose I select two Diggings as types of the others, for various reasons, and especially for these,—that, so far as I am aware, all the other Gold-fields may be classed in the category to which belong one or other of the two selected, or a combination thereof; and because they are the two with which from personal examination I am most familiar. The Gold-fields, or "Diggings," referred to, are those of *Otago* and *Auckland*, respectively; the one in the Middle, the other in the Northern Island—the one representing *alluvial mining*, as it is technically called; the other *quartz reefing*.

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* Drawn up in 1862, immediately after a visit to the Gold-fields of Otago and Auckland, New Zealand.

My remarks, moreover, apply to 1862, the period of my visit to the Gold-fields in question. I have not since seen reason to alter any of my opinions, or modify the results or records of my personal observations; on the contrary, the mining experience of the last two years has only served to confirm the predictions or assertions I ventured to make while on the spot.

I.—OTAGO GOLD-FIELDS.

In January, 1862, I paid a visit of some days, with a view to a brief geological survey, to the now celebrated, but then recently opened, *Tuapēka* Gold-field in Otago, inspecting in detail the three great "Diggings" comprised within its boundaries, viz.:—those of Gabriel's and Monroe's Gullies, Wetherstone's, and Waitahūna. During the three previous months my head-quarters, whilst engaged in a natural history survey of part of the province of Otago, had been on what is equally entitled *geologically*, though perhaps not *commercially* speaking, to the appellation of a "*Gold-field*," at Saddle-hill, about seven miles northwards from Dunedin, its capital.

Subsequently to leaving Otago I visited the other provinces of New Zealand. At Nelson I had the opportunity of examining gold from all the Gold-fields of that province. At Wellington Dr. Fetherstone, the Superintendent, showed me the gold of Terawiti, about twelve miles from the town of Wellington. And while established at Auckland for a few weeks, I spent some days on the Coromandel Gold-field, which is now rapidly rising into note, examining its geology in connexion with Mr. Simmonds, a gold miner of great Victoria and Otago experience, and who was subsequently appointed by the Government of Auckland director of the gold-prospecting parties in Coromandel.

From New Zealand, I passed over to New South Wales; and in Sydney had the advantage of inspecting the extensive and valuable Geological Museum of the Rev. W. B. Clarke, the most eminent of antipodean geologists, the vaticinator and pioneer of almost all the now famed Australian "Diggings," as well as the predicter in 1851 of the existence of gold in New Zealand. This museum is particularly rich in the gold-bearing rocks and gold of Australia and Tasmania. Nor did the geological collection of the well-arranged "Australian Museum" at Sydney fail in information concerning the same Gold-fields.

On return to this country I inspected the gold collections, as well as the series of associated auriferous rocks, where the latter exist, in the International Exhibition (London, 1862), the British Museum, and Museum of Economic Geology, London, and the Museum of Natural History in the University of Edinburgh; and I sought out the most recent information on the geology and mineralogy of gold and of auriferous rocks—all with a view to a comparison of the Otago gold and gold-bearing strata with standards with which we are familiar at home.

The scope of my present communication will not allow me to do more than merely *epitomize*, or give very briefly the general results of my observations or investigations; but this may suffice to satisfy the natural curiosity of the geological student regarding the natural history of one of the most recently developed and most important series of our colonial Gold-fields, and indicate how far the auriferous system of Otago resembles that of Australia, California, Brazil, Russia, Scotland, Wales, Ireland, or other auriferous countries, which are geologically better known to us.

I would concisely tabulate my results as follows:—

1. The golds and gold-bearing rocks of Otago do not differ essentially in mineralogical or geological characters from those of any other part of the world hitherto known to be auriferous.

2. The gold occurs originally in a quartz matrix, and this auriferous quartz occurs interbedded in, or associated with, metamorphic slates, especially gneiss, chlorite, and mica slates; the latter frequently highly ferruginous. These slates vary greatly in mineral character; in external appearance they are precisely similar to the corresponding rocks of Scotland (Grampians).

3. The slates in question are probably of *Silurian* age; this has as yet, however, to be *proved.* No fossils have hitherto been detected, and the subjacent rocks are apparently *granitic;* the *supposition* is hazarded mainly on the general resemblances, stratigraphical and lithological, between the slates in question and those of Australia, Russia, and Scotland.*

4. At various points in Otago there are evidences of considerable disturbance in the schistose strata by eruptive trappean masses. To such disturbance may be referred the frequent and sometimes sudden variability of dip within a comparatively limited space, the occasional faults and distortions of strata, and the accumulation of masses of "chopped slate" on the very irregular and frequently upturned edges of the mica and other slates.

5. Hitherto the "diggings" have been confined to the drift or alluvial deposits immediately superjacent to the slates in question, as these

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* The parallelism between the auriferous slates of Otago and Scotland is remarkable. I was struck with it while in Otago, and I have since traced and proved it by a personal examination of the Highlands of Dumfries, Lanark, Peebles, and Perthshires. The Lead Hills' district, for instance, may be said to be a second edition of Tuapeka—the configuration of hills and glens is the same; their geological formation is similar; gold is procurable under precisely similar circumstances, although in smaller amount, and there are to be seen in various parts of its glens and flats vestiges of the "diggings" of a bygone age. To this day, the lead miners, while idle on a holiday here, collect *alluvial gold;* and these specimens, specially collected for me by some of these men, exactly resemble the gold of Gabriel's Gully. My investigations satisfied me that gold is generally distributed, though in small quantity, throughout the metamorphic slate districts of Scotland, which extend from the extreme north (Sutherland) to the extreme south (Wigtown) of the country.

The Coromandel Gold-field, in the north Island, has in respect of its quartz reefs a greater resemblance to the Gold-fields of North Wales (about Dolgelly, in Merionethshire).

occur especially in the "flats" on the banks of streams, or at the opening out of glens or valleys. These deposits, or "drift," consist essentially of,

a. Clays or tills, mostly blue or yellow;

b. Boulders, generally boulder clays;

c. "Gravels," so called; but which are really more properly what the miners denominate "chopped slate," chiefly formed of the *debris* of the subjacent and circumjacent slates or other rocks, seldom or little rounded or water-worn. According to the character of the slates from which they are derived, these clays and gravels are coloured red or yellow, blue or green—the ferruginous mica slates being the origin of the first-named colour, gneiss of the second, and chlorite slates of the third.*

6. The auriferous "drift" appears to be of newer *Tertiary* age, this supposition being based on such facts as the *sub*-jacency of *lignites*, or brown coals, which are referable to the *older* Tertiaries.

7. The gold is partly granular, partly scaly, partly nuggety, and partly crystallized, and exhibits every gradation, intermixture, and variety of each of these forms or kinds.

8. It is associated, in different localities, with titaniferous magnetic iron sand, iron pyrites, garnets, and other minerals.

9. Metamorphic slates are probably the fundamental rock of Otago, that most widely distributed. Speaking in general terms, wherever they have hitherto been specially examined, they have proved to be auriferous; and wherever they may still be found, gold may reasonably be looked for. Gold has already been found in the gravels of the Mataura River; on the Waiopai Plains; in the Tokomairiro Plains; in the Woolshed, which lies between Tuapeka and the Tokomairiro; in the Waipori district; in the iron sand of the beach at Moeraki; near Waikowaiti; in the Lindis Burn, in the extreme north, and in many other localities; and I have no hesitation in affirming that it will yet be found much more widely, probably generally diffused, though nothing short of actual mining or digging can determine the exact localities of "payable Goldfields."

10. I consider the auriferous capabilities of Otago only in gradual process of development. Hitherto the operations of miners have been mainly confined to what are called "alluvial" or shallow diggings. Scientific quartz mining has not as yet been engaged in. The experience of all auriferous countries proves that in proportion to the richness of drift deposits, they are soon exhausted; that their richness, however, is an indication of the fertility of the quartzites from which the drift or alluvial gold has originally been derived; that these quartz-

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* The gold occurs chiefly in the so-called "gravel" or "chopped slate," which constitutes the "wash dirt" of the miner. It is frequently found most abundantly in "pockets" or crevices of the irregular upturned edges of the slates, on which the said gravel immediately reposes. It is also disseminated through the clays in many localities, and sometimes is collected in quantity in cavities under the boulders in the boulder clays.

ites are what gold miners must look to for *permanent* employment. It is regretable that the capabilities of the Otago auriferous rocks may not be tested or developed so fully and so speedily as is desirable, in consequence of the unfortunate position taken by the Otago Government towards the immigrant diggers or gold miners, who are mainly Australians. At the period of my visit these miners were very much dissatisfied with the policy and practice of Government, and there was then every reason to apprehend an exodus of diggers from Otago back to Australia on the approach of winter. It was then a subject of complaint that nothing was being done by Government towards the formation of roads in the Tuapeka district, existing roads being mere hill tracks, nearly impassable in wet weather; nothing towards the sale of adjacent lands, and the permanent location of a large proportion of the mining population; nothing towards the establishment of a market town, with all its advantages; nothing towards working the adjacent brown coals, or otherwise supplying winter fuel; nothing towards reform in unsatisfactory or impracticable mining laws. I trust, and indeed there is every reason to believe, that much of this unsatisfactory state of matters has been amended, though I have doubts as to whether it has been done sufficiently in time to prevent a reflux of a large proportion of the Australian population. Among other circumstances affecting the mining population in Otago, and thereby the development of its auriferous resources, may be mentioned the gradual rising into notoriety of the Gold-fields of Nelson and Auckland, which has determined a "rush" of diggers northwards; and the general dislike of Australians to the climate of Otago, particularly its winter climate, which they say contrasts most unfavourably with that of the majority of the Australian Gold-fields.

11. An estimate of the productiveness of the Tuapeka Gold-field may be formed from the following Table, extracted from the columns of a local newspaper:—

Amount of Gold exported from Otago.*

Years.	Ounces.
In 1861 (last six months), ...	187,695
In 1862, ...	397,602
In 1863, ...	580,233
In 1864 (first 7½ months), ...	333,982
Total, from the discovery of Tuapeka, in July, 1861, .	1,499,512 †

representing in value about five millions sterling.

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* This is exclusive of the considerable quantities of gold passing through *private* channels, and which cannot be precisely estimated.

† "Otago Daily Mines," August 18, 1864, taken from the Custom House returns.

I have repeatedly heard Otago miners of both Californian and Australian experience declare that no space of ground of equal extent in either of the countries just named had ever produced the same amount of gold within the same period as Gabriel's Gully, Tuapeka. However this may be, it would appear that the experience of Tuapeka has been that of Gold-fields in general: there has been an alternation or intermixture of great gains and great losses, some miners amassing fortunes, while others have been beggared. At the time of my visit, however, there was a population of about 12,000 persons in the various Tuapeka diggings, while the minimum or average wage for a common day labourer was one pound per day.

12. The provincial Governments of Southland, Canterbury, and Wellington, have lately offered substantial premiums (generally £1000), for the discovery of "payable Gold-fields" within the precincts of these respective provinces, a circumstance which will probably stimulate the energies of prospecting parties, and lead perhaps to the extension or multiplication of the existing Gold-fields of New Zealand. I have every reason to believe that new Gold-fields remain to be discovered; at all events I have no doubt as to the general distribution of auriferous slates belonging to one or other of the gneiss, clay slate, mica slate, talcose, or chlorite slate series over the whole New Zealand Islands, North and South, interrupted here and there, and to a varying extent, by formations of more recent origin, and consisting, largely at least, of the *débris* of these slates.

13. In order to afford an estimate of the present position and prospects of the various Gold-fields in Otago, I append quotations from the most recently arrived Otago newspapers, these quotations consisting mainly of the narratives of the various newspaper correspondents.

II.—AUCKLAND GOLD-FIELD.

In February, 1862, while sojourning for a time in the town of Auckland, in the North Island, I spent some days in a rough geological survey of the *Coromandel* Gold-field, distant about fifty miles from the capital, across the Frith of the Thames. This Gold-field and its products, though in certain respects they resemble, in certain others differ somewhat from, the Gold-fields of Otago as already described. By way of contrast or comparison, and as serving more fully to illustrate the general geology of the New Zealand Gold-fields, I have deemed it desirable to supplement my notes on those of Otago by similarly brief or concise remarks (being, as in the former case, simply the general results of my observations or investigations) on that of Coromandel, in the province of Auckland, geographically some 800 miles distant from, and further north than, the Tuapeka field in Otago.

The Coromandel Gold-field differs from that of Tuapeka in having been longer known, and in having been previously "worked," if the efforts of the few dozens of Auckland citizens who dug gold there in 1852 be entitled to this appellation. According to one of the most reliable historians of New Zealand, the late Dr. Arthur Thomson,* the field was deserted after a few months' occupation, the total yield of gold being 800 oz., or £1100 worth, which was collected at an expense of £2000 worth of labour! This experiment was felt by all parties to be unsatisfactory; curiosity was excited—anticipations given birth to; but it was not *proved* that Coromandel was a "payable Gold-field," a very small portion of it indeed having been at all operated on. Nothing further was, however, done towards the development of the auriferous resources of the Coromandel peninsula till the recent outbreak of the gold mania in Otago (1861). A sense of the advantages conferred on Otago by the possession of its valuable Gold-fields led the Auckland Government to consider the means of drawing a proportion of the immigrant mining population towards Coromandel. Negotiations were entered into with the native proprietors of that peninsula, and the result was a permit from the latter for European "*prospecting*" of a *portion* of their lands for gold. This privilege was set forth in such terms in the Auckland newspapers as to draw northwards from Otago a few dozens of the more restless or enterprising of the Australian gold miners. Disappointment and discontent on the part of the latter were the speedy result: they accused the Auckland Government of virtual misrepresentation, and certainly with every appearance of justice. The Auckland public prints, said they, set forth in much too favourable a light the privilege to be enjoyed, the auriferous riches of the ground open to prospecting, and the extent of district to be so prospected. They found the privilege of prospecting hedged round with so many restrictions as to be really of little value: certain large tracts of land were exempted; the Maori cultivations on the "flats" about Coromandel harbour—consisting of auriferous "drift"—were tabooed; and certain boundaries were established, over or beyond which the digger might not trespass. It so happened that these exempted or forbidden portions of land were just those which promised to be most auriferous—just those which the instinct of the miners led them to desire to prospect. Moreover, the privilege awarded was simply one of "*prospecting*," not of "*working*:" it was set apart for the enterprising miners to work out the problem whether the Coromandel Gold-field was a "payable" one; and in the event of this being determined in the affirmative, a basis would simply be afforded for further negotiations—for "working" the said Gold-field—between the Auckland Government and the Coromandel natives, it being by no means certain that the useful workers or solvers of the problem would ever be adequately rewarded, or rewarded at all for their toil and their risks. At the period of my visit, I found the few miners then on the spot so much discouraged by the state of affairs just referred to—by the incessant interferences of the Maori proprietors of the soil—the deficiency of proper mining tools in Auckland—the absence of stores of food—and the want of government assistance and patronage, that they were fast leaving Coromandel in disgust, bound either for Australian or for the Nelson "diggings." These men had not been afforded any proper opportunity of working out the experiment or problem as to the payable or remunerative character of the Coromandel Gold-field, while there seemed no difference of opinion in Auckland as to the desirability of a speedy solution of the question. So satisfied was I, on the one hand, of such desirability of setting forthwith at rest the question, "Whether or not the province of Auckland possessed a payable Gold-field at Coromandel, or elsewhere," as bearing most intimately, not only on the immediate welfare of the province, but on the more general and more serious so-called "Native question," which more or less involves the prosperity of the whole Northern Island of New Zealand; and, on the other, so convinced of the auriferous character of the Coromandel peninsula, and of the suitability of the Australian miners for practically deciding the *quæstio vexata* immediately at issue, if properly supported, and afforded the indispensable opportunities—that I united with a party of Otago miners, who had been my *compagnons de voyage* from Dunedin, in making strong representations to the Auckland Government, with a view to secure, *firstly*, a Government grant in aid of the efforts of the prospecting parties, to furnish them with tools and rations for a given period; and, *secondly*, more extended and real privileges in regard to the character and space of the district to be prospected. Apparently the Government and public of Auckland were quite alive to the desirability of both these aims or schemes; for a grant of £500 was forthwith made, and Mr. Simmons, one of the Otago miners in question, was appointed to the charge and disposal of this prospecting grant, and to the supervision of the prospecting parties. The services of the nomadic diggers were therefore retained for behoof of the province; and since that period (February, 1862), they have been zealously at work, with what success the public prints of Auckland satisfactorily show. The existence of a "payable Gold-field" can scarcely be said yet to be *proved*;* but this is not the fault of the prospecters. The error lies in the unsatisfactory relative position of the natives and Government in reference to the possession of the Coromandel peninsula. My conviction is firm, that so long as that tract of country is in possession—in part or whole—of the natives, it will be impossible to develope to the full extent, or perhaps at all satisfactorily, its auriferous resources, save at the risk of a serious collision between the two races, the Maori proprietors and the European immigrants—the consequences whereof it is difficult to estimate or predict. It seems to me that the Auckland Government has erred grievously in not having long ago purchased the freehold of the entire Coromandel district, which in fact was at one time offered for sale by the natives at a very cheap rate. Independently altogether of its gold, this district is rich in valuable timber; and it contains some of the finest scenery in the neighbourhood of the capital of New Zealand—scenery that, under happier auspices, might establish at Coromandel harbour the Brighton or Portobello of Auckland.

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* "Story of New Zealand," vol. ii., p. 197. London: 1858.

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* That Coromandel is now (1864) a "payable Gold-field" there can be no doubt. It has been proclaimed so long since by the Government of Auckland. Numerous joint-stock companies have been formed to mine and crush the quartz, and extract the gold; suitable machinery has been procured from Australia; numerous mines are in full operation; and the whole district visited by me in 1862 is now a scene of the busiest and most prosperous mining industry—a scene which probably attracts but little attention, simply by reason of the superior or more immediate interest attachable for the present to the guerilla war of the restless Waikatos and Taranakis.

I. The geology of the northern Gold-fields of New Zealand, including those of the provinces of Nelson and Auckland, does not differ essentially from that of the southern or Otago Gold-fields, as already described, save in so far as concerns certain minor details. The auriferous slate, for instance, is more usually clay slate than mica or chlorite slates; the associated quartzites are developed to a much larger extent, and the evidences of trappean disturbances are more numerous in many cases. Nor does the character of the gold itself differ materially, save in so far, perhaps, as at Coromandel it is more usually associated with its quartz matrix, mostly in the form of quartz pebbles.

II. At Coromandel the auriferous clay slate is scarcely visible; the whole district is mountainous, and is more or less covered with a dense virgin forest, more of the nature of Brazilian jungle than of the Australian "bush," rendering a geologist's researches extremely difficult. It is only here and there in the beds of streams or ravines that the slate occasionally "crops out;" nor is the quartz, which is largely interbedded in or associated with the slate, itself frequently to be met with *in situ;* here and there only it is to be found as a huge, irregular, wall-like mass or "dyke," forming the ridge, perhaps, of the great central dividing range of mountains. But the proximity and abundance of quartz are sufficiently indicated by the great numbers of huge quartz boulders or blocks which are strewn over the flat grounds, about the head of Coromandel harbour, and at the foot of the said dividing range. These blocks are generally more or less angular, though the angles are usually somewhat rounded off, their appearance indicating no great distance from their native "reefs" of quartz. In various parts of the district these quartz masses are accompanied by similar masses of basalt, which, however, are generally more waterworn, and appear to have travelled further from their origin.

III. The dividing range of the Coromandel peninsula consists of a backbone of mountains varying from above 1000 to 3000 feet of elevation, and runs nearly north and south—a direction which is by gold miners supposed to indicate, or be favourable to, auriferous riches, but which supposition is not always borne out by facts. The auriferous quartz reefs, which, from their superior hardness, usually project above the surface of the softer slates, forming frequently serrated, narrow, ridges, generally run in the same direction as the dividing range.

IV. The slates of Coromandel are very much altered by the trappean rocks with which they are generally more or less intimately associated. They are generally very much hardened, and they bear so great a resemblance to slaty basalts, particularly of the clinkstone class, as to be almost indistinguishable by the naked eye. Where they occur, or are laid bare, in ravines or streamlets, they are generally found more or less vertical or tilted up very obliquely, as in the bed of the Waiau, which forms the southern boundary *politically*, though not geologically, of the Coromandel Gold-field.

V. The prevalent trappean rocks, which burst through, overlie, or are otherwise associated with the slates, are mainly various tuffs and basalts. On the island of Wanganui, in Coromandel harbour, which was my head-quarters, I found a very hard breccia, formed to a great extent of fragments of jasper and flint, and various tuffs, which appear as if made up of the *débris* of *granitic* rocks; while boulders of syenite and basalt were scattered over the surface of the hills. This island seemed altogether trappean, composed mostly of tuffs or breccias.

Local geologists, such as Messrs. Heaphy and Swainson, describe the fundamental rock of the Coromandel mountain chain as granitic; and the granite as forming here and there the apices or aiguilles of the said chain or ridge. The papers of Mr. Heaphy especially (who was Gold Commissioner at Coromandel in 1852), in the "Journal of the Geological Society," * may be referred to with great advantage on the subject of the general geology of Coromandel.

VI. The Coromandel "Diggings" have hitherto been through the same superficial deposits, or "drift," as those of Otago. This drift consists essentially of,

1. Clays of different colours, more or less free from boulders;
2. Clays containing boulders, which are mostly trappean (basaltic); and,
3. Gravels, of the "chopped slate" character (apparently the *débris* of the component rocks of the adjoining ranges or mountains), resting immediately on the "bed rock," or slates.

In the latter, the gravels, as at Otago, the gold mostly occurs.

VII. But these auriferous "drifts" are comparatively of limited extent; the "flats" bear a small proportion to the mountain ranges, and are not likely of themselves long to support a large mining population. On the other hand, there is every evidence of abundant auriferous quartz "reefs;" and it appears to me altogether that the development of the auriferous riches of this district must be mainly by means of *scientific quartz mining*,—an operation that requires not only a high degree of skill, but a large amount of capital. This Gold-field differs materially in its characters from that of Tuapeka: there you have a bare open country, consisting of gently undulating "ranges," like the lower parts of our Lammermoors or Ochils; "flats" are prevalent, large open level valleys, and accessible streams; auriferous drift is abundant, while quartz reefs are developed to a comparatively small extent. Here, on the other hand, is a rugged, inaccessible, mountainous, densely-timbered country, cut up by deep, sometimes precipitous gorges or ravines; the flats at the mouths of valleys insignificant; the drift sparingly distributed, while quartzites are developed to a comparatively large extent. It is evident, under these differences of physical conditions, that the nature of the gold mining must also be very different in the two places. It is as yet impossible to hazard any estimate or opinion as to the auriferous richness of the Coromandel quartzites. The abundant experience of Australia, and more recently of the Welsh gold mines, shows that the extraction of gold from auriferous quartzites, which contain no gold visible to the naked eye, may yet be most remunerative, though it shows, further, that the degree or extent of this remunerativeness differs greatly on the nature of the processes employed, processes based partly on chemistry, partly on mechanics, the result of the most recent applications of science. I have a high opinion of the auriferous richness of these Coromandel quartzites, and of the yield they will give, when science is properly applied to the extraction of their wealth; and I may make the same remark in regard to the auriferous quartzites of Otago and Nelson.

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* "On the Coromandel Gold Diggings in New Zealand," vol. x., p. 322 (1854); and "On the Gold-bearing District of Coromandel Harbour," vol. xi., p. 31 (1855).

VIII. Coromandel gold occurs in the granular, scaly, and nuggety form, frequently as scaly nuggets. What I saw was generally inferior in quality to the greater part of Otago gold, and more resembling in value some of the Nelson gold. But the specimens submitted to me by the gold miners were usually contained in rounded quartz pebbles, the quartz frequently of a brownish or ochrey colour; the gold was generally disseminated in such a manner through the quartz as to have a dendritic appearance or character; the pebbles seemed frequently richly veined with the finest gold. The quartz blocks so abundantly scattered over the flat lands about the head of the Coromandel harbour, and up the valleys of the Kapunga and Waiau, frequently consist of the porous spongy quartz so common on many of the Australian diggings, and its colour is frequently buff, brown, ochrey, or vermilion tint, the result apparently of ferruginous impregnation. The shingly bed of the Kapunga stream, on the banks of which the earliest diggings were situated, consists mainly of *débris* of a dirty brownish-yellow quartz. The quartz fragments and blocks become more numerous and larger in proportion as we approach the mountain ranges.

IX. The drift gold is associated at Coromandel with titaniferous iron sand, exactly resembling that which is so well known as the produce of the beach at Taranaki; it seems to occur along with gold in almost all of the New Zealand Gold-fields.

X. "Gold has been found at Victoria, in the interior of the North

Island of New Zealand," says Dr. Thomson.* This locality is at the south end of the range of mountains which forms the backbone of the Coromandel peninsula. There is every probability, I think, that this whole range, which according to local geologists would appear to consist of Silurian slates, is, along with the drifts therefrom derived, auriferous. Not only so—gold has been recently found in other districts of Auckland province, and at Rangitik, Taranaki, and other localities in the province of Wellington. From the description of the prevalent rocks given me by settlers in other parts of these provinces, particularly of Auckland, I feel little difficulty in predicting that auriferous rocks and deposits will yet be found much more widely scattered than is at present known over the North Island of New Zealand, perhaps more particularly in the province of Auckland. I would venture strongly to recommend, therefore, not only systematic prospecting for gold, wherever the metamorphic slates occur, but in all the drifts derived from granitic and hornblendic rocks. In Australia, and other auriferous countries, gold is frequently derived from granites and syenites. In New Zealand this is very seldom the case; but there is at least one good instance, according to Haast, in the province of Nelson, in the bed of the rivers Roto-iti and Rotoroa, where the gold could apparently only have been derived from the decomposition of rocks of a granitic or hornblendic character. I would strongly commend this circumstance, that Silurian slates are by no means the only sources of gold even in New Zealand, to New Zealand gold miners, convinced as I am that much remains to be done to adequately develope the auriferous resources of that country—resources of which, in reality, little can as yet be said to be known. But I would go further, and point out to the Government of Auckland the fact that the present unsatisfactory information as to the gold-bearing rocks of that province is only one illustration of the extreme desirability of a thorough and immediate *geological survey of the province.* Another perhaps equally forcible illustration may be found in the coals or lignites of Auckland, which are only now beginning to be worked and applied to useful purposes; but only a few deposits or beds of which are known, as compared with those which I have little doubt remain to be discovered. Otago has taken the lead in the appointment of a competent geological surveyor, and in the initiation of a systematic geological provincial survey; Wellington is following. Nelson and Canterbury have had partial surveys of a superficial kind; and Auckland, which should have set the example, is still greatly behind the times in this respect, and is thus standing very materially in its own light. It is true that the geologist of the Austrian Exploring Expedition, Dr. Hochstetter, of the "Novara" frigate, has made valuable contributions to the geology of Auckland; and in noticing such contributions we must not omit to mention the repeated and most interesting geological papers of the present Surveyor-General of Auckland,

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* "Story of New Zealand," vol. ii., p. 198.

Mr. Heaphy, or the labours of other *local* geologists. But these labours have achieved little compared with what remains to be achieved, and which can only be accomplished by a regular geological survey, extending over several years, and implying an expenditure of from £5000 to £10,000.

XI. It is difficult to form a comparative estimate of the auriferous richness of the North and Middle Islands of New Zealand. So far as I have been able to judge from personal observation, from the narratives or papers of geological and other travellers, and from the descriptions of settlers, there seems reason for supposing that the auriferous slates are more largely developed in the Middle than in the North Island, and that, consequently, the yield of gold should be greater in the former. It is, perhaps, of little importance to speculate at present on this subject, seeing that there can be no doubt, I think, that auriferous rocks and deposits abound in *both* islands to an extent that will require years to determine, and that the development of the auriferous resources of New Zealand is yet in its infancy. It will not fail to be observed that the obstacles to the development of the Gold-fields at Coromandel differ entirely in character from those in Otago; in the former they are altogether of a more formidable kind. The possession of the soil by the Maoris is the first great barrier to progress at Coromandel, though the physical nature of the country is one scarcely of subordinate importance. But, these obstacles being successfully overcome, there are advantages at Coromandel not possessed by Otago. Among these may be mentioned proximity to Auckland, and easy carriage of stores and tools, abundance of timber for fuel, houses, and mining, and a very superior climate, leaving out of view romantic scenery, which, though not directly influencing the miner, perhaps does not fail to add to the amenities of his existence.

The present position and prospects of the Coromandel Gold-fields may be gathered from the appended quotations from Auckland newspapers, recently received. From these it would appear that the efforts of the diggers have been greatly facilitated by an extension of the prospecting privileges, as well as perhaps by other privileges or advantages secured from the natives by Sir George Grey. Past experience, however, teaches me, I regret to say, to accept all such *newspaper* accounts *cum grano*, and to allow a wide margin for differences between the representation and the reality. There seems no reason to doubt, however, from whatever causes, that progress is being made, though slowly, let us hope surely, in the development of the auriferous resources of Coromandel, and of the North Island of New Zealand generally.

"Two escorts have reached town since our last summary, bringing down gold as follows:—23rd August, 14,088 oz. 11 dwt.; September 6th, 12,637 oz. 11 dwt.; total, 26,726 oz. 2 dwt. The total export of gold from New Zealand, from 1st April, 1857, to 30th June, 1864, is 1,554,069 ounces, of the value of 6,015,630*l*. The exports are thus divided:—From Auckland, 26,939*l.*; Nelson, 262,867*l.*; from Nelson and Picton (being the produce of Marlborough Gold-field), 27,919*l.*; Canterbury, 91*l.*; Dunedin and Bluff (being the produce of Otago Gold-fields), 5,697,814*l.* The exports of the quarter ending 30th June were:—Auckland, 5,095*l.*; Nelson, 17,676*l.*; Marlborough, 27,919*l.*; Canterbury, 91*l.*; Otago, 537,658*l.*—making in all for the quarter an export of 588,439*l.* From this it will be seen, that in proportion to our population, which was reduced by at least 10,000 during the first six months of this year, that the yield per man of our Gold-fields was greater during that period than during any previous half year."—*Otago Mail*, September 17, 1864.

"GOLD STATISTICS.

"The quantity of gold exported from the province of Otago during the current year to this date is 361,995 oz. 2 dwt.

"The quantity previously exported is as follows:—

Years.	Oz.
1861,	187,695
1862,	397,602
1863,	580,233
	1,165,530

Making a grand total since the discovery of the Gold-fields of 1,527,525 oz. 2 dwts., the value of which, at the English Mint price, is nearly 6,000,000*l.*

"The escorts have brought down the following quantities of gold during the current year:—

Month.		Oz.	Dwts.
January	12,	15,766	6
"	26,	16,569	8
February	9,	21,780	7
"	27,	16,262	0
March	12,	14,936	3
"	28,	22,678	15
April	6,	21,435	11
"	19,	22,214	0
May	3,	22,565	5
"	17,	17,172	1
Carried forward,		191,379	16
Brought forward,		191,379	16
May	31,	13,108	0
June	14,	12,732	18
"	29,	10,411	0
July	12,	12,692	7
"	26,	11,721	0
August	9,	14,917	15
"	23,	14,088	11
September	6,	12,637	11
Total,		293,688	18

"*Otago Daily Times*," September 17, 1864.

XXX.—Description of a New Palæchinus. By Joseph Wright, Esq. Plate VII.

[Read before the Royal Geological Society of Ireland, March 9, 1864.]

The first notice we have of the genus Palæchinus was in a short paper read by Dr. Scouler before this Society in 1840, when two specimens were exhibited; but these were so deeply imbedded in the stone, that little could be ascertained respecting their structure. Four years afterwards, Sir R. Griffith published his great work on the Irish Carboniferous Fossils, and in this Mr. M'Coy figured and described no less than five distinct species of Palæchinus, all of which were peculiar to the Carboniferous rocks of Ireland.

Palæchinus quadriserialis (Nov. sp.).

Elliptical; ventral and dorsal ends equal; interambulacra composed of two rows of pentagonal and two rows of hexagonal plates; two rows of pores on each side of the ambulacra; six to seven ambulacral plates, equal to the width of one of the lateral interambulacral ones. Length, two inches; width, 1½ inch.

This species may be known from *P. ellipticus*, the only one with which it can be confounded, by having four instead of five rows of interambulacral plates, differing in this respect from all previously described species, and even from the generic characters as laid down by M'Coy.

DESCRIPTION OF PLATE VII.

Fig. 1, *a-c*, *Palæchinus quadriserialis*; *a*, side view, natural size; *b*, interambulacral plates, natural size; *c*, ambulacral plates, enlarged.

XXXI.—On some New Points in the Structure of Palæchinus.

By William Hellier Baily, F. G. S. & L. S.

Plate VIII.

[Read before the Royal Geological Society of Ireland, March 9, 1864.]

Having occasion to examine the important collection of fossils belonging to Sir Richard Griffith, Bart., which includes the examples of Palæchinus figured in the Synopsis of the Carboniferous Fossils of Ireland, I observed amongst them a slab from Hook Head, in the county of Wexford, upon the weathered surface of which three beautiful specimens of *P. elegans* were exhibited, although somewhat crushed. One of these still retained the plates of the *apical disc*, an important part of the *test* or shell which has, I believe, never before been described. (An exact representation of this fossil is given on Plate VIII., Fig. A.)

The great difference between the Palæozoic Echinidæ and those of succeeding and more recent epochs consists in the much larger number of plates entering into the composition of the *test* in these ancient forms of Echini, the genus Palæchinus, so far as at present known, having from four to seven columns of *interambulacral* plates, whilst the Echini of the Secondary, Tertiary, and Recent periods are confined to two rows only.

It became, therefore, an interesting question to determine whether these Carboniferous examples of the group presented a corresponding difference in the arrangement or number of the plates of which the *apical disc* is composed. This I was enabled to decide by the discovery of these parts in the specimen before alluded to, which, although slightly displaced from their original position, were in sufficient preservation for that purpose.*

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* Since this Paper was written, I have, through the kindness of Mr. R. H. Scott, been enabled to examine a second specimen of this species from Hook Head, in the col-

After a careful examination, I found that in, accordance with the general characters of the order *Echinoidea*, the Palæchinus has five *genital* (*a*) and five *ocular* plates (*b*), making together ten plates to form the first or principal circle; the former perforated for the passage of the *ovarial* and *seminal canals*, the latter for the lodgment of the eyes. These plates, however, present the remarkable peculiarity of a *triple* perforation of each of the genital, and a *double* perforation of each ocular plate, suggesting an increase of the functions to which they were adapted corresponding with the large number of plates composing the test or shell of this ancient representative of the Echinoidea.

There are also two inner circles of plates surrounding the anal opening: those next the principal series (*c*), consisting of eight plates, correspond with what are called the *sur-anal*, in the *Saleniadæ* and some other more recent genera; the third circle is less complete; the number of plates composing it appears to be about ten, but, owing to displacement, they cannot be counted with certainty.

The principal plates differ in their proportions from those of the more recent examples of Echini, the genital plates being broader than long. What I presume to be the *madreporiform* plate, which should belong to this series, is unfortunately denuded of its surface, so that I could not ascertain the presence of the characteristic markings which usually distinguish it. The plate I believe it to be is rather larger than the others, as usually the case; all the other plates belonging to the two principal series are covered with granulations. A restored sketch of the apical disc, enlarged four diameters, is given on Plate VIII., Fig. B.

An additional point of interest in the structure of this extinct genus is that of the discovery of spines, which I had observed some time previously on examining a fragment of one of these fossils, from the same locality, in the collection of the Geological Survey of Ireland. These spines are exceedingly minute, being rather less than the tenth of an inch in length, and on being submitted to microscopic examination were found to be longitudinally striated (a figure of one of them, enlarged twnety diameters, and a line to show the natural size, are represented at Fig. E); they are principally dispersed over the plates of the *ambulacra* and in its immediate neighbourhood, and were most probably the spines belonging to that series of plates.

On applying a magnifying power to one of the *interambulacral* plates, the mammillated or granulated appearance represented in the enlarged figure of a plate of this species in the Synopsis of Carboniferous Fossils of Ireland, Plate 24, Fig. 2 (*c*), resolved itself into distinct tubercles, *primary* and *secondary* (an intermediate plate of this character is drawn, enlarged eight diameters, at Fig. C). The larger or *primary* tubercles

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lection of the Royal Dublin Society, with the apical disc preserved, which, although not so clear in its details, retains more of its original position, and is so far satisfactory as to confirm my observations in that respect, founded upon the specimen in Sir Richard Griffith's collection.

were seen to be distinctly perforated for the attachment of the spines, and surrounded by a circle of about ten smaller *secondary* ones (Fig. 5).

These additional details of structure go far to complete our knowledge of the shell or outer case of these ancient forms of Echini, which, although apparently furnished with a more complicated arrangement of parts, by the much larger number of elements composing it, will, I think, be found to exhibit merely a repetition of the same characters which prevail in their representatives at the present day.

XXXII.—SOME ADDITIONAL NOTES ON THE STRUCTURE OF PALÆCHINUS. By WILLIAM HELLIER BAILY, F. G. S. & L. S.

[Read before the Royal Geological Society of Ireland, April 12, 1864.]

SINCE my last communication to the Society on this subject, I have, through the kindness of Mr. Michael George Ryan, been enabled to examine an additional specimen of *Palæchinus ellipticus*, which he has liberally presented to the Geological Survey; that gentleman having been so fortunate as to knock out two examples of this rare fossil from a block of Limestone used in the construction of a drain at his then residence, Bettyville, near Croom, in the county of Limerick. As frequently happens, a very important part of the fossil was left behind in the Limestone in which it had been imbedded, the cast only having come out, divested of its shelly covering; this, however, may eventually be obtained, as he kindly promised to make inquiries, and if possible secure it for the Palæontological Collection in the Museum of Irish Industry.

Having all the examples at present known of this species intrusted to me for examination, I can safely say that this specimen, by its more complete condition, exhibits some additional particulars with regard to the structure of its test, and enables us on other points to confirm what before was merely conjectural.

In the first place I believe it presents us with good evidence of a mouth opposite to the apical disc, and corresponding with a similar arrangement of parts in recent Echini, as on this cast of the interior of the shell can be traced a termination of the plates in a slightly reflected edge, round an opening of about four lines in diameter; this part would no doubt be more clearly defined in the mould which represented the original shell.

Professor M'Coy, in his definition of the characters of this genus,* describes it as possessing a central mouth, and "ovarian plates as in Echinus:" this vague description, without any figures of the parts being given, has to a certain extent proved to be correct; for, although some important differences occur in the details of this apical or ovarian disc, the analogy is still very striking between these Palæozoic forms and the more recent examples of Echinidæ. He describes the plates to be covered with spiniform tubercles, *destitute of central ligament.* I find the tubercles and spines to be, however, distinctly perforated, indicating a ligamentary attachment, a fact which shows how necessary it is for observers to confine themselves to what they really see, instead of hazarding a statement as to the presence or absence of any character, on imperfect or even negative evidence.

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* "Synopsis of the Carboniferous Fossils of Ireland," p. 171.

Major Austin, in "The Geologist" for December, 1860, gives an outline figure of what appears to be one of the ambulacra of a species of Palæchinus, from the lower beds of the Carboniferous Limestone at Hook Head, in the county of Wexford. This fragment he considers to have belonged to a true Echinus, distinct from Palæchinus, and deems it to be of sufficient importance to form the type of a new genus, which he calls *Proto Echinus;* I regret that on a recent visit to the Hook I was unable to verify that gentleman's opinion as to its unique character, although so successful in that wonderful district for fossils as to meet with several examples of *P. elegans*, a species which is, I believe, confined to the lower or shaly beds of the Limestone. In the paper by Major Austin, to which I have referred, he also gives 'some observations on the genus Palæchinus,' in which he states that, "from specimens in his cabinet there was great reason to infer that the different species belonging to this genus possessed columns similar to the true Crinoids." This conjecture, for which I believe there is no real foundation, may have arisen from the specimen upon which Major Austin drew his conclusions having a portion of a Crinoid column lying in close contact with a Palæchinus; not at all an improbable occurrence. The arrangement of the apical disc, corresponding so generally with that of the Echini, shows them to have been more nearly related to the free Echinoderms, and would quite set aside the idea of their being stalked; in such a case the question might naturally be asked, Where, then, would the mouth be situated? The specimen for which we are indebted to Mr. Ryan assists considerably in confirming me in this opinion, as it appears to have a distinct oral termination at the opposite pole to that of the apical disc as in Echinus, an arrangement quite in accordance with its other structural peculiarities.

This Palæchinus also illustrates another very interesting fact, viz., that of the graduation or passage of one group into another, by the presence of some characters common to both, as shown by the ornamentation or strengthening of the plates composing the shell, which are seen to be covered by radiating ridges proceeding from their centres to each of the angles (Plate VII., Fig. 2 *a*), presenting a very similar appearance to the markings which occur on the external surface of the plates of many of the *Cystidea*, and some of the Palæozoic Crinoids, such as *Glyptocrinus* and *Actinocrinus.*

I had hoped to have procured a sight of the second specimen in Mr. Ryan's possession before the meeting of the Society on this occasion, thinking it might, perhaps, have shown more clearly some of the peculiarities of structure I have alluded to. Mr. Ryan, however, informed me that it was packed up at Limerick, with other articles, previous to his going abroad. At a future time, however, I hope to have an opportunity of examining it.

The specimen he has presented to the Survey agrees with that belonging to Mr. Joseph Wright, as far as can be seen, in having four rows of interambulacral plates only. I do not, however, consider their agreement in that respect as presenting sufficient grounds for making either it or Mr. Wright's specimen a new species, as that gentleman has thought it advisable to do; or as indicating anything more than a variety of *P. ellipticus*, to which it bears so close a resemblance in general form and other particulars; knowing also, from the specimens I have examined, how variable other species of the same genus are in that respect.

EXPLANATION OF THE PLATES.

Plate VII., Fig. 2, *a*, *b*.—*Palæchinus ellipticus*, nat. size; Carboniferous Limestone; Bettyville, Co. Limerick.

(*a*). Side view, showing the plates covered by radiating ridges.
(*b*). End view, looking down upon apical disc.

Plate VIII.—*Palæchinus elegans;* Lower Carboniferous Limestone; Hook Head, Co. Wexford.

Fig. A. Side view of crushed test, with apical disc, natural size.
B. Apical or genital disc, enlarged four diameters; (*a*) five genital plates; (*b*) five ocular plates; (*c*) eight sur-anal plates; (*d*) ten do., inner circle, incomplete.
C. One of the interambulacral plates, enlarged eight diameters, covered with tubercles for the attachment of the spines.
D. A primary tubercle, perforated, and surrounded by a circle of smaller or secondary tubercles, still more highly enlarged.
E. A spine, enlarged twenty diameters, striated, and having the base perforated for its ligamental attachment to the primary tubercles.

XXXIII.—ON A NEW ECHINODERM FROM THE YELLOW SANDSTONE OF DONEGAL. BY WILLIAM HARTE, Esq., C. E.

Plate IX.

[Read before the Royal Geological Society of Ireland, April 13, 1864.]

THE fossil I now beg to lay before the Royal Geological Society of Ireland, and which I present to the Museum, I got lately near Lough Esk, about six miles from Donegal. The road along the western shore of the lake runs through Arenaceous Limestone; and on the left, going northwards, lies a bed of Limestone to which I shall have to refer again. This changes to Sandstone a little higher up; and through this the Board of Works have partly made a road, in the cutting of which, just where it crosses the "Eglish" road, the fossil was found.

I now describe the shell, so far as defined by the fossil, which is a cast in a good state of preservation, the markings being, indeed, unusually sharp for one in Sandstone (Plate IX.)

The shape is orbicular, depressed. The base is absent, and the cast seems to have yielded by pressure, and is spread out, somewhat of a bell-mouthed shape, though this has been effected with very little distortion or disarrangement of the plates.

The interambulacral spaces are composed at the lower extremity of the fossil of five rows of plates, and it is very probable they exceeded that number at the base. The two rows next the ambulacra are pentagonal, except the upper plates, which are nearly triangular.

The other three rows are hexagonal, very irregular, and nearly all become obsolete before reaching the anus. These hexagonal plates are almost smooth, or at least only marked by very minute tubercles, of which I think traces can be detected; but the genital and side pentagonal plates are very different.

The genital plates have each a large perforate tubercle, as in *Archæocidaris*, surrounded by a depressed ring, and this is again surrounded by a ring of about sixteen pores (Plate IX., B.)

Of the rows next the ambulacra, the first plate (counting downwards from the apex), which is nearly triangular, has a small tubercle. The rest of the plates in this row are all pentagonal, as I have remarked. They increase in size downwards, as do also the tubercles.

The second plate has a large tubercle; this is surrounded by a depressed ring, and this again by a ring of very small tubercles.

The third plate is plain.

The fourth plate has a large tubercle, surrounded by the depressed ring and ring of tubercles, as in the second plate.

The fifth and sixth plates are plain, like the third.

The seventh plate is tubercled, and surrounded by the depressed ring and tubercles, as in the second and fourth plates.

The foregoing description applies to all the five interambulacral divisions, so that thus we have a series of concentric circles of tubercled plates in the pentagonal rows, at increasing distances from the anus down.

The ambulacra are large; the perforations are situated in two depressions; these perforations consist of three pairs of pores in each ambulacral depression (Plate IX., A.) Four of the ambulacral plates equal in depth one of the pentagonal side plates. The dividing ridge shows the ambulacral plates well, having one small tubercle in each; a detached portion of either this same or another of these Echinoderms appears on the same stone, close to it, showing the plates of the ambulacra very distinctly.

There is no trace of any spines that I can see in this fossil. Unlike the fossils of *Archæocidaris*, to which I shall allude farther on, this Echinoderm was evidently rolled, or stripped of its spines, before being buried in the sand; but I have found in the same bed, and near the same place, a few detached plates of the animal, and I think the casts of some spines; and I also find traces of large plates in some of the very friable shales near it.

The fossils associated with this Echinoderm do not seem to be numerous, but I send a good specimen of *Psammodus porosus*, found in the same beds.

In the Limestone bed to which I have alluded, just under the Yellow Sandstone, I find a great number of fossils; but by far the most characteristic are those of *Archæocidaris*, which occur in the greatest profusion. They are found in groups of plates and spines; nearly all these groups present more or less the same assemblage of pentagonal and hexagonal plates, the latter tubercled, with numerous spines both smooth and muricated, giving the idea that each of these groups represent the remains of one or more of these animals as they there fell to pieces.

I exhibit several of these specimens. In no case do I find among them any pentagonal plates tubercled like those of the Sandstone fossil; and differing as it does from Palæchinus and Archæocidaris, I think there can be no doubt but that it is a new addition to the Echinoderms of the Carboniferous series.

XXXIII.—ON THE ANTIQUITIES AND HUMAN REMAINS FOUND IN THE COUNTY OF DOWN, IN 1780, AND DESCRIBED BY THE COUNTESS OF MOIRA IN THE "ARCHÆOLOGIA," VOL. VII. By SIR WILLIAM WILDE.

[Read before the Royal Irish Academy, June 27, 1864.]

IN the autumn of 1780, the body of a female, clothed in antique woollen costume, was discovered in a bog, at the eastern foot of Drumkeragh Mountain, in the barony of Kinalearty, and county of Down, the circumstances attending which, as well as the character of the costume, have been described by the distinguished Countess of Moira, in a letter, forwarded to the Society of Antiquaries in London, in 1783. That communication has been long known to Irish antiquarians, and appreciated for its learning and patriotism; and I myself and others have often regretted that that remarkable discovery had not taken place in our own times, so that an opportunity might have been afforded us of examining the costume, or procuring it for the Museum of the Academy. Owing, however, to the liberality of one of our members, the Earl of Granard, the great-grandson* of the original describer of these remains, I am now enabled to present to the Museum of the Academy the great bulk of the articles which came into the possession of Lady Moira nearly eighty-four years ago. From an examination of some of these specimens, it is manifest that a series of "Warp lifts," supposed to be a comparatively modern invention, was in use in Ireland when these articles were manufactured.

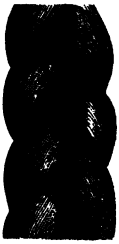
---

* Lady Elizabeth Hastings, Baroness Hastings and Hungerford, &c., in her own right, and Countess of Moira, was mother to Lady Selina Rawdon Hastings, Countess of Granard, from whom the present Earl inherited those portions of costume and hair referred to in the text.

In the memoir in the "Archæologia" it is said that the human figure referred to was found buried in hard gravel, beneath 4½ feet of bog, "and that upon and about the bones there were many garments." It was also stated that the circumstances under which the body was found showed evidences of burial; and also that the bog had been some years previously nearly eleven feet deep in that spot. I have, however, been by long experience so accustomed to receive with great caution all accounts of such matters afforded by the peasantry, even where a shorter interval has existed between the discovery and the recital than that recorded by Lady Moira, that I think we must receive with caution details of that nature.

The hair of the individual was long, silky, and of a deep chestnut colour; but how far this brownish-auburn tint is the original shade of the hair, or the result of the bog colouring, is questionable. Its present hue would be much coveted in our own day. The plait was formed of three strands, interwoven after the manner depicted in the adjoining woodcut, and closely resembles the mode of wearing the hair in vogue among children and young girls a few years ago. The entire plait is now fourteen inches long.

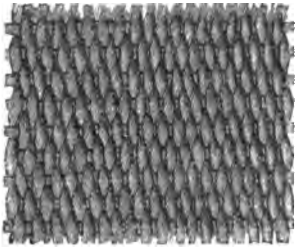
No. 1.



All the articles of costume described by Lady Moira were woollen—thus indicating that at the period to which they refer there was no linen or other vegetable fabric employed in that part of the country. What their original colours may have been it is now difficult to determine; but at present they present several varieties of brown, from a dark orange, through the various shades of russet and sienna, to a colour almost black. More, however, may be gleaned from the texture, and manufacture, and pattern of the fabrics, than from the colour. All the seams and hems are made good with woollen thread of the same colour as the texture which they joined; and as there are some evidences of patching and mending, we must conjecture either that the materials were obtained with difficulty, or that the person was of inferior rank. In fineness, as well as quality and pattern, they vary exceedingly. Ten specimens have been preserved, and each differs from the other in colour, grist of thread, and arrangement in weaving. Some of them were evidently the chief garments of the person, and were intended for warmth and protection, while others appear to have been of a decorative character. The accompanying illustrations represent the most remarkable of these patterns.

No. 2, accurately figured in this engraving, is a coarse camlet, probably the petticoat, in which the threads of the weft are hard and well twisted, but those of the warp are much thicker and softer. They intermingle, not as in a homogeneous piece of weaving, like modern cloth or linen, but having the warp standing in high relief, so as to present a corded surface, like that which is known in modern phraseology as "rep," and which is not unlike coarse Egyptian linen.

No. 2.



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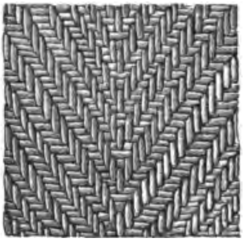
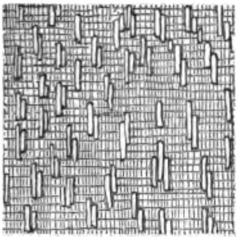
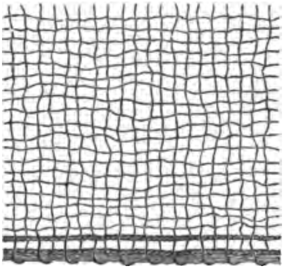


No. 3 is of a finer quality, but nearly of the same colour and closeness. The pattern is what is termed herringbone, and the weaving superior in quality to the foregoing. The portion under consideration has been much patched, and a piece of the same manufacture forms a patch upon the long strip of the following.

No. 4.



No. 5.

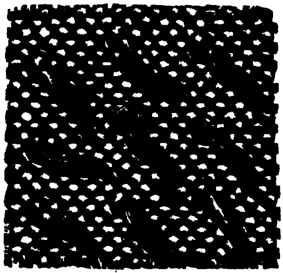


No. 4 is a thin, loosely woven, and open huckaback, as shown in the foregoing cut; it has a broad thick hem running along the edge; in colour it is nearly of a tint with the two preceding patterns.

Somewhat like No. 2, is a beautiful soft fragment, with a diaper twill, and of a light warm colour, partaking of a shade of orange. It probably formed a part of the cloak or mantle. Of the same colour, but of a light serge texture, there is a small fragment of woollen stuff still remaining; likewise some portion of cording, apparently used in tieing or confining the dress.

The two remaining articles are of extreme interest. One of these, No. 5, is evidently a fragment of a light gauzy woollen veil, of the most delicate texture, and which it was believed by Lady Moira was of a greenish colour when first brought to light. The other, No. 6, is a piece of very closely woven hard firm thick mohair camlet of hair, not wool, and having on its outer surface rows of elevations, from each knob of which depended a small black tab, so that originally the cloth must have presented an ermine appearance. The colour is now a reddish-brown, but the remains of the tabs are quite black. This may have been part of the tunic. Even during the present century ladies' cloaks, tippets, and pellerines, and gentlemen's dressing gowns, were ornamented with ermine-like appendages of this nature.

No. 6.



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CONTENTS OF No. XIX.—JULY, 1866.

WITH FOUR PLATES.

PAGE

1. Notes on the Physical Features of the County of Donegal. By W. Harte, C. E. (Plate VI.), ... [illegible]
2. On a Polished and Striated Surface in the Limestone of Ross Hill, Co. Galway. By M. H. Ormsby, B. A., L. C. E., ... 201
3. Notes on Animal Mechanics:—No. 3, On the Muscular Mechanism of the Leg of the Ostrich. By the Rev. Samuel Haughton, M. D., Fellow of Trinity College, Dublin, ... 20[illegible]
4. Notes on Animal Mechanics:—No. 4, On the Muscular Anatomy of the Lion. By the Rev. Samuel Haughton, M. D., Fellow of Trinity College, Dublin, ... 210
5. Notes on Animal Mechanics:—No. 5, The Muscular Anatomy of the Seal. By the Rev. Samuel Haughton, M. D., Fellow of Trinity College, Dublin, ... [illegible]
6. Some Remarks on the Doctrine of Characteristic Fossils. By John Kelly, ... [illegible]
7. On the Geology of the New Zealand Gold-fields. By W. Lauder Lindsay, M. D., F. R. S. Edin., &c. &c., Honorary Fellow of the Philosophical Institute of Canterbury, New Zealand, ... [illegible]
8. Description of a New Palæchinus. By Joseph Wright, Esq. (Plate VII.), ... [illegible]
9. On some New Points in the Structure of Palæchinus. By William Hellier Baily, F. G. S. & L. S. (Plate VIII.), ... [illegible]
10. Some additional Notes on the Structure of Palæchinus. By William Hellier Baily, F. G. S. & L. S., ... [illegible]
11. On a New Echinoderm from the Yellow Sandstone of Donegal. By William Harte, Esq., C. E. (Plate IX.), ... [illegible]
12. On the Antiquities and Human Remains found in the County of Down, in 1780, and described by the Countess of Moira in the "Archæologia," vol. vii. By Sir William Wilde, ... [illegible]

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Nº XX.
OCTOBER, 1865.

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XXXV.—THE ICEBERGS OF THE SOUTHERN HEMISPHERE. By J. M. BARRY, M. D., L. R. C. P. D., L. R. C. S. I., M. R. D. S., M. R. Z. S., &c., &c.

[Read before the Royal Dublin Society, May 15, 1865.]

THE Icebergs of the southern hemisphere possess so many points of interest, and differ so considerably from those met with in the northern hemisphere, that I have thought a paper on the subject might prove somewhat interesting, more especially as I have recently received communications from practical men, accustomed to navigate annually that portion of the Southern Ocean most infested with ice impediments.

The points of greatest interest, perhaps, are whether Icebergs between fifty and sixty south latitude have of late years become more numerous?

Are they to be met with further west in the Pacific than formerly?

Do they last more than one season?

Where do they drift to?

And does their presence sensibly affect the temperature of the air and water?

I may first make a few general remarks on the subject, and then bring under your notice the communications alluded to.

The Icebergs of the southern hemisphere are much larger than those of the northern, being frequently reported by vessels as attaining an altitude of 1000 feet, 200 and 300 feet being their ordinary height, and from one to ten miles in circumference. In appearance they assume every variety of form, tabular, or irregular with hanging cliffs, penetrated with caverns; sometimes they shoot up picturesque pinnacles; they are at all times awful and imposing objects, especially during the prevalence of fogs and gales.

Icebergs appear to have their origin on or in close connexion with the land, and are generally the result of several years' frost.

The accumulated masses of snow and ice on the sides of mountains, and the glaciers formed in deep valleys, are gradually pushed towards the sea shore, increasing year by year into gigantic dimensions. Onward these ice cliffs, partly ice, partly snow, with rock gravel and earth imbedded in them—they creep along until projected into water sufficiently deep to float them, when enormous fragments become detached. Thus Icebergs are calved, and they drift to lower latitudes, melting by degrees with the increasing temperature.

Captain Ross sailed along land, in these Antarctic regions, fringed for upwards of 450 miles by an unbroken barrier of ice, 180 feet in height, flat and level at the top, without any fissure or prominence on its seaward face. Behind this wonderful object stood Mount Erebus, an active volcano, sending forth smoke and red flames. Ice detached from this barrier, as well as from other Antarctic shores, annually finds its way north into the track of homeward bound ships in the South Pacific, and encumbers the ocean chiefly between the parallels of 80° and 120° west longitude—no parallel of latitude to the southward of 45° being probably altogether free from these obstructions to navigation.

One of the most remarkable instances I have found recorded of impediment from ice is the case of the "Arethusa," which vessel sailed from Van Diemen's Land on the 4th of January, 1833. She crossed in about lat. 57°; and it is probable, to judge from the report, that few vessels have encountered more danger, or seen a more continuous succession of Icebergs in the Southern Seas. The log says:—"We expected to see ice, but were totally unprepared for the hardships in store for us."

"The first ice fell in with consisted of fourteen ice islands, some of them 800 feet high. From this critical position we escaped only to fall in with an almost impassable barrier in lat. 57°, south, long. 93° W. There was ice as far as the eye could reach. Having entered the barrier, it became hazy, with small rain; the little distance we could see showed nothing but stupendous masses of solid ice of all possible shapes, the greatest distance between them being about a quarter of a mile. They were so closely packed together, that until nearly approached no opening could be observed. In passing some of the bergs the noise they made in cracking from the effects of thaw was awfully sublime, in many instances resembling a peal of thunder. The last Iceberg seen by the 'Arethusa' was in 78° W." For twenty days they were navigating through ice, during which the crew had little rest or comfort.

In September, 1840, an Iceberg was seen in lat. 41° 30′ S., long. 14° E., a mile in circumference; in February, 1848, in 48° S. long. 37½° E., a berg seven miles in extent was reported; in October, 1854, another equally large; in January, 1858, in lat. 53° 30′ south, and long. 51° W., an Iceberg three miles long was observed; but all these appear insignificant, when compared with a body of ice reported to have been passed by twenty-one ships during the month of December, 1854, and January, February, March, and April, 1855, floating in the South Atlantic, between latitude 40° south, long. 20° W., to 44° S. and 28° W. It was most probably an immense chain of Icebergs, its elevation in no case exceeding 100 feet. It was of a hooked-shape form, sixty miles by forty, with a space of water forming a bay forty miles across. The first account of it was received from the "Great Britain," which in December, 1854, was stated to have steamed fifty miles along the outer-side of the greatest limb.

The longest range of ice bore N.E. and S.W. The bay being open in this position, you will perceive it exposed ships to but little danger; but during the next three months it changed its position, and drifted E.N.E. about 100 miles, which brought it very near the route of outward bound ships, with the bay open to their track.

One emigrant ship, "The Guiding Star," was embayed, and lost among it, with all hands. The "Cambridge" and "Salem" were also embayed in it in March, 1855, but through the skill of their commanders were finally extracted from their most perilous situation.

There is a region in the South Atlantic which I have marked out on the chart before you, within which Icebergs more or less in number may be found at all seasons of the year. On the equatorial side of this curve ice is only found occasionally, and it is not improbable that many of the reported isles and shoals of the South Atlantic were bergs which had floated to low latitudes, freighted perhaps with masses of rock. Vast quantities of ice exist south of the parallel of 57° on each side of Cape Horn; it rarely, however, approaches close to the Cape. It is also found in great abundance between 49° and 55° S. between the meridians of 40° and 50°. The enormous masses found to the west of the meridian of Greenwich are formed on the land due south of Cape Horn. Explorers and persons engaged in the whale fishery tell us of vast accumulations of ice in this region; the entire space of water between some of the islands being filled with compact field-ice, and bergs sometimes as elevated as the islands. The average number of Icebergs to be met with to the southward of 57° during the Austral summer may be 100 per day. Storms in these regions are fearful. Icefields and floes, driven about under the agency of winds and currents, are piled up into ridges; coming into collision with Icebergs they are broken to pieces, and dashed about in all directions, and it requires the coolest courage and most practised skill to extricate a vessel.

The number of Icebergs obstructing the route of passenger ships varies annually. The reports of vessels show this to be the case. The records of Antarctic exploration endorse the same statement: if the quantity has been small during two or three years, the accumulated mass is subsequently disengaged, and finds its way north.

Sir James Ross crossed Weddel's track in latitude 65° S; and where Weddel found clear water Ross came upon an icepack, along which he sailed for 160 miles, only one degree beyond the track of Cook, who does not state that he was inconvenienced by ice in this position. Ross was navigating among it for fifty-six days.

From August, 1854, to April, 1855, the whole Southern Ocean, and especially that part of the Atlantic to the southward of the curve which I have laid down on the chart, was so occupied with ice, that no ship could sail through it without incurring great risk. The "Golden Era" was caught in it; the "Red Jacket" lost a week endeavouring to get clear of it; the "Champion of the Seas" had her homeward passage greatly prolonged; the "Cambridge" and the "Salem" were nearly lost, and the "Guiding Star" totally, with all hands.

The greatest number of Icebergs are met with between New Zealand and Cape Horn; and it is a mistake of serious consequence to suppose that they do not exist during the winter season. I am sure during the long winter nights vessels pass Icebergs unconsciously. The maxim ever should be, in prosecuting these passages, that ice must not *necessarily* be met with, but *may* be encountered at any season of the year. I may quote a few abstracts, illustrating the dangers encountered from Icebergs round the Cape of Good Hope and

Cape Horn, and between the two capes. H. M. ship "Sirius" sailed from Port Jackson in 1788; she fell in with Icebergs in lat. 57° S. and 76° west, and was constantly among Icebergs. Even when in sight of Terra del Fuego, being bound to the Cape of Good Hope, she passed across the dangerous track marked on the chart. Her log informs us that the sea was here covered with them; the last ice seen was in latitude 44° south, and longitude 35°. The "Seringapatam," on a voyage to Calcutta in 1840, fell in with ice in 38° S., and long. 1° E. The bergs were evidently breaking up; one berg upset, turning completely over; the ship was surrounded with ice for many hours. The "Constant," in September, 1844, saw thirty-two Icebergs in lat. 38°, and long. 24° E. "The Day Spring," on a voyage to the Mauritius, in December, 1855, in lat. 56° and long. 40°, sighted numerous ice islands, which seemed to form an impenetrable barrier. The ship was hauled to the northward, and continued to pass from ten to fifteen bergs a day, until she arrived at lat. 52°, and long. 20° west.

"The Crawfords" sailed from Callao in March, 1858, having rounded Cape Horn, and got as far to the north as 50°, kept to the eastward, and in consequence got among numerous Icebergs in long. 47°. The weight of experience is in favour of vessels, after rounding Cape Horn, steering a course to the northward, past the Falkland Islands, never going to the eastward of 50° W. long. until they are to the northward of lat. 50°; they should then not steer a more easterly course than would bring them to the point of junction of 40° south and 40° west.

I may be here permitted to remark, that having attained to this degree of northing, it is more prudent for vessels to get into the heart of the south-east trade. If northerly winds prevail, and they get down on the Brazilian coast, by keeping too long on the starboard tack, in the hope of the wind becoming easterly, they will have to beat up the coast from 20° south to a little north of Pernambuco, and it must be a smart ship that will beat sixty miles per day under these circumstances.

I was passenger on board ships on two occasions; on one we were detained thirty days, and in the other case seventeen, on this coast, daily expecting a change of wind to the southward of east; but in neither case did we fall in with a S. E. wind until we were to the northward of Pernambuco. One of these passages was in January, the other in May.

To return from this digression to the Icebergs—Maury, in his remarks on the "Icebergs of the Southern Seas," says that navigators can scarcely ever venture to the polar side of 55°, except while passing Cape Horn, without encountering Icebergs. They may be seen drifting up towards the Equator in large numbers all the year round, many of them miles in extent, and hundreds of feet thick. Maury informs us that he encountered bergs in the parallel of 37° south. The belt of ocean encircling the globe on the polar side of 56° is never free from them; this space comprehends an area of 17,784,600 square miles. The nursery for the bergs to fill such a field must be an immense one;

it cannot be on the sea, for icebergs require to be fastened to the shore until they attain full size; they are therefore evidence in favour of Antarctic shore lines of great extent, of deep bays where they may be formed, and lofty cliffs whence they may be launched.

From an examination of the logs of 372 English vessels outward round the Cape of Good Hope, and 192 round Cape Horn homeward, it appears that of the vessels round the Cape of Good Hope one in sixteen record ice, one in six of those round Cape Horn report Icebergs. With the exception of June and July, there is no perceptible difference in the average of years in the Cape Horn route; but the chance of encountering ice in sailing to the Colonies round the Cape of Good Hope is three times greater from September to May, both inclusive, than during the months of June, July, and August. It is an error to suppose that Icebergs require water seven times deeper than their apparent height above the sea level to float them; this altogether depends upon the solidity of the ice. Her Majesty's Ship "Chanticleer" was in contact with an Iceberg fifty feet high—which according to the rule would require not less than 350 feet to float it, but it was found to be drifting in ninety-six feet of water.

With respect to the increase of Icebergs of late years, Captain Henry of the "Omer Pasha," informs me that the increase of ice in the South Pacific since 1861 is most remarkable: previous to that year he made many passages from Australia at all seasons, running his easting down between 55° and 59° south latitude, and saw but little ice—in fact, three voyages not any; during the last four years they might be counted by hundreds each passage, some of them of immense size; in 1861 he saw a block of ice fully six miles along, and apparently 500 feet high, its sides quite perpendicular. "There can be little doubt," says Captain Henry, "that of late years there has been some enormous breaking up of ice in the southern hemisphere."

Captain Arnold, of the "Marco Polo," considers they are much more frequent of late years, and especially this season, which he thinks is marked by the presence of more ice in the South Pacific than any year since 1856; but thinks that it is unnecessary to look for any special cause further than the circumstance that, like many other natural phenomena, they are more frequently encountered some years than others.

Captain Johnstone, of the "Lightning," who has had great practical experience, having unfortunately run into an Iceberg when he commanded the "Marco Polo," is of opinion that ice is greatly on the increase in the South Pacific. He sailed from Melbourne in 1854, saw no ice; in July, 1859, did not encounter any, neither in 1860, in which year he sailed from Melbourne in March; sailing the same month, 1861, he saw the first ice in 53° S. and 170° W. longitude, in 160° W. saw much ice, then no more until he arrived at 55° S. and 142° W., when the ship came into collision with a large berg in the middle watch; at day-light the ship was in the centre of a great many bergs.

Captain Johnstone was so fortunate as to extricate his ship the "Marco Polo," which was in a most disabled condition, and brought her into Valparaiso.

All the ships which have arrived in London since February report having passed through immense numbers of bergs; one vessel states that Antipodes Island was sighted, four bergs being visible at the same time—this is most unusual; another ship states that ice was met with all across the Pacific, even to Cape Horn. This also differs from former experience, the vicinity of the Horn being usually free from ice impediments.

I have myself made six voyages round Cape Horn, and my observation leads me to conceive that there must be some agency in operation within the Antarctic circle recently, not hitherto existing, at least in so active a form, which may account for the great increase of Icebergs within the last two years.

In 1863 I returned home in the "Young Australia;" we fell in with ice in 120° W. long., and were clear of it finally when we were to the eastward of 101°.

This year, in the "Lightning," we sighted a berg in 175° W., or about 150 miles to the eastward of Antipodes Island; then again in 120° we continued passing ice to 74°, and counted more than 100 bergs. The weather during the greater part of the time being very foggy, we probably passed many more than we saw.

Captain Arnold thinks ice is more common now further west than formerly; at least, for some voyages, he has regularly met with ice between New Zealand and 180°, and a little south of latitude 50°. He attributes its being here, and again not for many degrees on either side of this position, to the current which sets to the southward past the east coast of Australia preventing any ice from working north in its influence, and again a broad southerly current which he believes exists between 130° and 180° W. He conceives that between these two there is a tongue of eddy current to the northward, which carries a few large bergs up, renewing them from time to time, as they melt irregularly, some seasons more, some less. Still the quantities of ice seen by several ships this season, scattered over the Pacific Ocean, would imply that there is some new current or other influence in operation. This is an interesting question for discussion.

As to the dissolving of the ice, Captain Arnold thinks some large bergs do not break up for several years, but that the changes in their surface, arising from their turning over, and the action of the air and water, would make it very difficult to recognise them.' Captain Johnstone is of opinion that it would take years to melt some he has met with.

Captain Henry conceives that, from their magnitude, it would be impossible for them to dissolve every year; the time they last necessarily depending on the rapidity with which they are drifted to the northward; but if we are to take the estimated rate at which they are supposed to travel northward and eastward, it would take more than one season for them to reach a parallel sufficiently genial to dissolve them with rapidity.

For my own part, I feel confident that two bergs I saw in 120° W. and 53° S. in the year 1863, were again sighted the following year in latitude 51° 40′, and 115° W. They were much worn; one had a hole in the centre, which at a distance looked like a mass of rock; the relative position of this to the rest of the berg, and the remarkable and peculiar outline of both, led me to exclaim at daylight on the 10th December last, when I was called up, "Surely I saw those bergs last year!"

To what extent does ice affect the temperature of air and water? On this point there is great diversity of opinion: navigators in the northern seas almost invariably have noticed the thermometer sensibly affected on approaching ice; and Mr. Towson, who has written much on the ice of the southern hemisphere, thinks a watchful attention to the change in the temperature of air and water the best guide navigators can have of approaching Icebergs.

Captain Johnstone found little change in his thermometer when in contact with the ice, and was watching it carefully for hours before the "Marco Polo" struck.

Captain Arnold thinks it very unsafe to rely on the thermometer indicating an approach to ice. He has often found it not at all affected, or very slightly, by the presence of large quantities of ice. He thinks the constant cold of the Iceberg region of the South Pacific prevents the thermometer being such a useful monitor as it is said to be in the North Atlantic.

Captain Henry informs me that he has only found the temperature affected when ice was dead to windward; for several voyages he paid particular attention to the thermometer, but latterly has given it up, as the difference was so little when among bergs and when none were in sight, that it can be no guide whatever.

He graphically observes, in his communication to me, that a good look-out kept by three or four hands is better than keeping your eyes fixed on a thermometer; and when it becomes so dark and thick that you cannot see, "Stop her."

Captain Henry, I should say, is a safe and judicious navigator in those dangerous waters.

Now, my own experience of the thermometer does not lead me to form a very favourable opinion as to its utility in indicating the approach to ice.

On the 14th January, 1864, I was in the South Pacific; for some days before, the temperature was 44° and 43°, the water 44° and 45°; on this day we encountered ice, the temperature of the air being 43°, water 44°. On the 20th, three days after we had seen ice, the temperature of the air was 42°, and the water, 44°.

On the 9th of December, with ice in sight, the air was 48°, and the water 42°. This would seem to imply that the water was affected by the presence of the bergs; but off Cape Horn, on the 17th, we have the temperature of the air 45°, three degrees lower than it was on the 9th with bergs all round.

From the observation of successive years I would conclude that the thermometer, if closely watched, will show a difference of temperature in air and water when in the vicinity of these ice islands; but the difference is often so trifling, and requires such a good instrument and close observation as to render an ordinary thermometer on the deck of a ship, or the occasional testing of a bucket of sea water, quite useless in a practical point of view; and the fact of no change being observed in the temperature would certainly not warrant the commander of a ship in running during a dark thick night. The cause of the disaster to the "Indian Queen"—which vessel ran into an Iceberg, narrowly escaping destruction—was probably due to the opinion prevailing at that period as to the infallibility of the thermometer indicating the approach to ice. It is right, however, to state that some persons are of opinion that both sea and air are influenced by the vicinity of Icebergs; and that the not infrequent fogs which occur about them is caused by the condensation of aqueous vapour. When to the leeward of ice, the air is cool; when to windward, the water through which the ice has drifted is cooler.

My experience does not lead me to coincide with the correctness of this view, or, at all events, of its application practically in navigating ships through icy seas.

Captain Macdonald, when in the "James Baines," often met with a considerable number of Icebergs in his Australian passages; but is of opinion that they do not materially increase the risk, as it is only requisite to notice the thermometer to be forewarned of the approaching danger. In one case he found the thermometer fell four degrees as he approached the ice, and two more as he got to leeward of the berg.

The log of another ship informs us the thermometer in the morning indicated a temperature of 49°, and fell to 42° at mid-day on approaching towards an Iceberg.

Captain Newland, in the log of the "Champion of the Seas," states that the thermometer not only indicates the approach towards ice, but also the amount we may expect to meet with.

In latitude 58½° south he passed two Icebergs, the temperature of the air being 42°, and water 44°. He passed thirty-nine Icebergs in lat. 50°, the thermometer falling to 36°. In this instance the temperature was some six or eight degrees lower, although the ship was some eight degrees nearer the Equator, at which point the mean temperature is ten degrees higher.

The reports informing us that the thermometer is not at all affected by the neighbourhood of Icebergs are very numerous indeed, and should impress on all rational minds the necessity of keeping a most careful look-out night and day.

The late Dr. Scoresby, in his "Journal of a Voyage to Australia and Round the World," remarks on the subject under our consideration, that he cannot agree with Mr. Towson's view as to the security against falling in with ice to be derived from watchful attention to the temperature of the sea, or the thermometer being capable of insuring safety by giving indications of an approach towards ice. No doubt, in the vicinity of large bodies of packed ice, or of numerous Icebergs near together, the thermometer will show a reduction in the temperature of air and water in certain relations to the direction of the drift of the ice, sometimes to considerable distances. The unusual lowness of the temperature of the water indicates a descending polar current, and therefore a greater probability of ice being met with; but it is impossible to apply these changes of temperature in air or water with any certainty to determine the approach to ice. It is an excellent practice to note the temperature of the sea in these regions, provided we do not altogether rely on thermometric indications. The chilling or radiating influence of an isolated Iceberg cannot sensibly affect the temperature of the air to windward of it, nor could the sea be altered in its general temperature for miles around, except in the track of the drifting bergs. Fragments of bergs in a gale and heavy sea will always be found nearly astream of the Iceberg—that is to say, in the line of the wind from the berg to windward or to leeward. Hence, it is a useful precaution, in sailing among Icebergs at night, to pass them well on one side with respect to the direction of the wind, so as not to intersect the stream line of the ice. Next to a careful look-out, the most important circumstance to be attended to is, giving such attention to the adjustment and quantity of sail during the night or misty weather, when ice has been seen, or may be reasonably supposed to be not far off, as may allow for hauling up or bearing away in the event of sudden necessity. In the long dark nights of winter, when the moon is not nearly full, ice, particularly the low, less visible fragments, are specially to be guarded against. In the summer of the Southern Seas there is so little night, that ships may run with security, provided the weather is clear. Unfortunately fogs are but too frequent with the prevailing north-westerly winds. Lastly, it is to be hoped that the experience of future years will convince navigators, if indeed we have not already acquired information sufficient to satisfy commanders of ships, that as good passages may be made from Australia to Cape Horn by running down their easting in 50°, as far as 110° or 115° W. long., and then edging down to Cape Horn in 55° 58′, as by incurring the great risk, without any commensurate advantage, of going as far south as 60° for the sake of shortening the distance some 500 miles; it cannot be with the hope of having fairer winds, for the weight of experience is in favour of easterly winds prevailing to the southward of 60°, and the parallel of 45° on the outward bound passage is deemed the parallel where the brave west winds most steadily blow during a greater part of the year. I have spoken to several of the most experienced commanders in the Australian trade, and they all agree with me as to the views which I put forward on this point. I trust that this slight sketch of the ice phenomena met with by voyagers in the Southern Seas may only prove the prelude to other papers of greater extent and value. I know not a more interesting field for observation, or more calculated to elevate our minds, than the physical geography of the ocean.

XXXVI.—ON THE CHEMICAL VALUE OF MANURES, AND THE SILURIAN LIMESTONE OF COURTOWN HARBOUR, COUNTY OF WEXFORD. By GEORGE WALLER, C. E.

[Read before the Royal Dublin Society, April 24, 1865.]

AT an evening meeting held here during the Spring Cattle Show of last year, a Paper was read by Mr. Lawes, "Upon the Feeding of Cattle;" and in connexion with the subject he stated, "that it was unnecessary to supply carbon in a manure, inasmuch as a manure without carbon produced a crop superior to that in which carbon had been largely supplied." He then pointed out the value of nitrogen in manures. At the close of the lecture I rose to ask Mr. Lawes the question if, as he affirmed, it was unnecessary to supply carbon in a manure, why was it necessary to supply nitrogen, both elements being derived from the same source, the atmosphere, and supplied gratuitously by it?—that I was acquainted with a manure which contained neither carbon nor nitrogen, and that on light lands it had proved itself equal to, if not superior to, all known manures (farm-yard not excepted), not in the production of one or two crops, leaving the land permanently exhausted, but in the production of a series of good crops; that it enabled light lands to produce herbage vastly superior to that which could be produced by any other manure, and that I used to exhibit specimens of herbage produced by it, and from the *debris* of the stone, without the presence of any dirt, which I now do; that it seemed to be the peculiar property of this manure to produce this herbage upon all the lands to which it was applied; that it contains only a trace of phosphate, and yet is capable of producing a series of good corn crops on the most exhausted light lands; that it is valuable also as an hydraulic lime. I alluded to the Silurian Limestone of Courtown Harbour, near Gorey, in the county of Wexford—a conglomerate Limestone, perhaps the only known variety in which all the earthy constituents of grain crops, green crops, and grass exist in certain proportions, and in certain chemical combinations, peculiarly fitted, as it were, for the production of these crops.

Before noticing the components of this Limestone, and thence deducing its value as a manure, I propose to offer a few remarks respecting the constituents of plants and the sources from which they derive their food; for we must understand the composition of a plant before we can affirm the class of food required for its growth and development. Agricultural plants, as many of you are aware, are composed of two classes of constituents—the combustible, or gaseous, which are derived from the atmosphere; and the incombustible or earthy, which are derived from the soil. The combustible, or gaseous, constituents are composed of oxygen, hydrogen, nitrogen, and carbon, and are derived from carbonic acid, water, and ammonia. When a plant is subjected to the action of fire, or during decomposition, these combustible constituents return to the atmosphere whence they were derived, leaving behind the incombustible, or earthy, in the form of ashes. The incombustible, or earthy constituents of plants left behind in the form of ashes, are composed of phosphoric acid, potash, silicic and sulphuric acids, lime, magnesia, iron, and chloride of sodium, all of which are indispensably necessary for the growth and development of the plant. If there be a deficiency of any one of these constituents in the soil, the deficient constituent must be supplied artificially. Now, as there is always a large supply of carbon, oxygen, hydrogen, and nitrogen in the air to form carbonic acid and ammonia, it is unnecessary to supply that which is gratuitously supplied by the atmosphere. Our attention should rather be given to the supply of the incombustible, or earthy, constituents, which are not supplied by the atmosphere, and which, if removed from the soil by cropping, cannot be restored unless by artificial means.

But in order to understand the particular incombustible, or earthy, constituents we are to supply, it is necessary to determine the class of crop we purpose to grow. This being determined, we know from analysis the principal incombustible, or earthy, constituent which that crop requires for its growth and development. Now, as silex, lime, potash, and soda, respectively, predominate in the ashes of our cultivated plants, so these plants have been known under the name of silex plants, lime plants, potash and soda plants; silex predominating in the ashes of corn plants and grass, lime predominating in the ashes of potatoes and leguminous crops, potash and soda predominating in the ashes of green crops. We may, therefore, fairly infer that soluble silex, not insoluble or green silex, should predominate in any food we supply for the production of corn crops or grass; lime in any food we supply for the production of potatoes or leguminous crops; and potash and soda in any food we supply for the production of green crops; and we may also infer, that if these minerals do not predominate in any food we supply for the production of these crops, respectively—nay, further, if we do not supply as much of these minerals as we remove by these crops, respectively—the impoverishment of the soil must follow, as a matter of course.

Now, as artificial manures supply only about half the quantity of incombustible, or earthy, constituents that is removed by one of our cultivated crops; and as by the supply of combustible, or gaseous, constituents they stimulate the soil to yield much larger quantities of incombustible, or earthy, constituents than they supply, so I may fairly affirm that artificial manures, used as manures, or in place of manures, tend to exhaust and impoverish the land, and deprive it of its fertility; but when these manures are used as stimulants for the production of green crops to be fed off upon, or ploughed into the same land, or carried to the farm-yard to be converted into manure for the same land, or, in other words, when these so-called manures are used as stimulants for the production of manure for the same land the following season, no one will advocate their value more strongly than I would.

Unfortunately, however, they are not always purchased with this object in view. Within the last few years they have been extensively used by the small farmers in the county of Wexford (most probably in other counties also), as a substitute for manure in the production of green crops—the number of cattle on such farms being small, but now considerably reduced, from the past failures of crops, and bad prices; the quantity of manure on such farms being also always small, but now also considerably reduced—whilst from time to time these lands have been exhausted from over-cropping, and then stimulated by over-liming. To enable these lands to recover their fertility, artificial manure is purchased, a green crop produced, and the farmer proceeds to lay down the land the following year in good condition with a crop of corn and grass seeds, or he proceeds, before doing so, to take off a crop or two of corn, to repay himself for his outlay. He finds himself, however, miserably disappointed in the results. He is not aware that green crops are the most exhausting crops he can cultivate; "for," says Liebig, in his "Letters on Agricultural Chemistry," p. 129, "turnips require for their growth a very large quantity of mineral matter." Again, p. 131, "the quantity of food which a plant obtains from the same soil is in proportion to its absorbent root surface;" and as in the green crops he has removed from the soil a larger quantity of the incombustible, or earthy, constituents than he has supplied in the artificial manure, the deterioration of the soil must follow as a matter of course. In fine, the supply of artificial manures to such lands under the circumstances would be analogous to the supply of whiskey to an exhausted labourer, with a view of stimulating him to exertion beyond his natural strength.

Now, whilst landlords are being alarmed about over-liming, they are little aware of the greater injury resulting from the injudicious use of artificial manures. I have already observed that, when farmyard manure cannot be procured in sufficient quantity for the production of green crops, I would recommend the purchase of artificial manures, the crop when raised to be ploughed in or fed off upon the same land, or else the crop to be removed to the farmyard, there to be converted into manure to be restored to the same land. It matters little which of these three systems are pursued—they are all alike beneficial to the land; the first can be pursued by the farmer who has little or no stock, but is the most unprofitable; the second can be pursued with great advantage on light land and high-lying farms, and is the most profitable, because attended with the least possible outlay; the third entails the expense of carting the crop to the farmyard to be converted into manure, and the expense of re-carting it to the land when converted into manure, and is suited for farms where cattle must be housed during the winter months. In each of these three cases the minerals removed by the crop are restored either by ploughing in the entire crop, or in decomposing it on the ground, and ploughing in the decomposed crop, or in the restoring to the ground the crop decomposed in the farmyard, which latter has probably the added incombustible constituents of the straw and hay and corn upon which the animals in the farmyard have been fed.

Having now pointed out the circumstances under which artificial manures exhaust and impoverish the soil, and the circumstances under which they may be made the means of improving the soil, I now come to consider the means of maintaining the fertility of our well-cultivated farms. "There exists," says Liebig, "a receipt for insuring the fertility of our fields and the permanence of their crops, and which, properly and consistently applied, will prove more remunerative than all the expedients that have ever before been resorted to by agriculturists; it consists in the following rule:—Every farmer who takes a sack of corn, or a hundred weight of rape, turnips, potatoes, &c., to the town ought, like the Chinese coolie, to carry back with him from the town an equal, or, if possible, a larger quantity of the mineral constituents of the produce sold, and restore them to the field from which they have been taken." Accordingly, when an alternate system of husbandry is pursued upon a farm, the grain produced is sold in the market, and is not restored to the land in the form of manure; and as the head of corn cannot be produced without the presence of lime, I would say, purchase annually a certain amount of lime to supply the lime constituents sold in the market in the form of grain, or use marl, when marl can be obtained; by such means the fertility of their farms will be maintained.

I shall conclude by a testimonial given by Mr. Richards, of Ardamine, January 22, 1861, attesting its value in growing mangolds:—"The mangold wurtzell grown on my land this year on Courtown lime were far superior to those alongside grown on guano and on Lawes' superphosphate, a fair trial having been given in contiguous drills. The land had been manured under beans the previous year. The return of the produce of each drill when pulled was, under lime, 19½ stones; under guano, 15 stones; under superphosphate, nine stones." The herbage I exhibited this evening is grown on the *debris* of the limestone, and below the level of the sea, and has sprung up spontaneously. The variety, I believe, is not known in agriculture; and I believe, considering the season of the year, in specimens I may challenge competition. A similar one may be seen in abundance growing among the rocks at the works.

XXXVII.—On a New Table and Formula for determining Altitudes with the Barometer. By Stephen M. Yeates.

[Read before the Royal Dublin Society, January 13, 1865.]

The extreme portability of the Aneroïd Barometer having made it a favourite companion of almost every tourist, the want of some ready and accurate method of deducing heights from its indications has been much felt. One of the first steps this way is a little pamphlet, published by Mr. Belville, of the Royal Observatory, Greenwich, in which he gives the following simple rule:—"As the sum of the readings of the Barometer is to their difference, so is 55,000 to the elevation required." He also gives a Table, computed by the same rule, which is intended to give at a glance the approximate height corresponding to any depression of the Barometer; but as the altitudes given by the Table vary in many cases several hundred feet from the true height, it is quite useless.

Admiral Fitzroy suggested a modification of Mr. Belville's formula, and computed a new Table, which has been published by the Board of Trade; but this has the same objection as Mr. Belville's, and gives results nearly as remote from the truth; and what renders them still more useless is, that no correction for any change in the atmosphere can be applied to either so as to obtain more accurate results. This arises from the most important element—namely, temperature—not being taken into consideration in the formula.

Upon thinking over the matter, I considered that a more useful Table might be constructed by computing the altitudes corresponding to every twentieth of an inch of the mercurial column at one fixed temperature and latitude. These conditions being known, a correction might easily be applied for any change in either; accordingly, the following Table has been computed throughout for the mean temperature—32° Fahrenheit, and latitude 45°. To correct it for any other temperature, it is only necessary to increase or decrease it by the $\frac{1}{900}$th of itself for every degree of difference between the temperature of the air at the time of observation and that at which the Table has been computed. Thus—if t and t' denote the temperature of the air at the upper and lower stations, h the height given by the Table, and l the tabular number for the latitude, then

$$\frac{(t + t' - 64)h}{900} + h = H$$

and

$$H + (Hl) = \text{true height}.$$

The correction for latitude is + for all latitudes from 0° to 45°, and − from 45° to 90°. In most cases it may be neglected altogether, as the greatest error that could arise from its neglect in the most extreme case would be very small; so that for all practical purposes H may be taken as the true height.

Note.—If this Table be used with the Mercurial Barometer, the two readings of the Barometer must be reduced to one temperature, by increasing the colder the $\frac{1}{10000}$th of its height for every degree of difference of temperature.

Bar.	Height in Feet.	Bar.	Height in Feet.	Bar.	Height in Feet.	Bar.	Height in Feet.	Bar.	Height in Feet.	Bar.	Height in Feet.
31·00	00	28·00	2667	25·00	5638	22·00	8988	19·00	12830	16·00	17334
30·95	42	27·95	2714	24·95	5690	21·95	9048	18·95	12899	15·95	17416
·90	85	·90	2762	·90	5743	·90	9108	·90	12969	·90	17498
·85	127	·85	2809	·85	5796	·85	9168	·85	13038	·85	17581
·80	170	·80	2856	·80	5848	·80	9227	·80	13108	·80	17663
·75	212	·75	2903	·75	5901	·75	9287	·75	13177	·75	17746
·70	255	·70	2950	·70	5954	·70	9348	·70	13247	·70	17830
·65	298	·65	2997	·65	6007	65	9409	·65	13318	·65	17913
·60	340	·60	3045	·60	6061	·60	9469	·60	13388	·60	17997
·55	383	·55	3092	·55	6114	·55	9530	·55	13459	·55	18081
30·50	426	27·50	3140	24·50	6167	21·50	9590	18·50	13529	15·50	18166
·45	469	·45	3188	·45	6221	·45	9652	·45	13600	·45	18251
·40	512	·40	3235	·40	6275	·40	9713	·40	13671	·40	18336
·35	555	·35	3283	·35	6328	·35	9774	·35	13743	·35	18421
·30	599	·30	3331	·30	6382	·30	9836	·30	13814	·30	18506
·25	642	·25	3379	·25	6436	·25	9897	·25	13885	·25	18592
·20	685	·20	3427	·20	6490	·20	9959	·20	13958	·20	18678
·15	729	·15	8476	·15	6544	·15	10021	·15	14030	·15	18765
·10	772	·10	3524	·10	6599	·10	10083	·10	14102	·10	18851
·05	816	·05	3572	·05	6653	·05	10145	·05	14175	·05	18938
30·00	859	27·00	3621	24·00	6707	21·00	10207	18·00	14247	15·00	19025
29·95	903	26·95	3669	23·95	6762	20·95	10270	17·95	14320	14·95	19113
·90	947	·90	3718	·90	6817	·90	10333	·90	14393	·90	19200
·85	991	·85	3767	·85	6872	·85	10395	·85	14466	·85	19288
·80	1035	·80	3815	·80	6927	·80	10458	·80	14540	·80	19377
·75	1079	·75	3864	·75	6982	·75	10521	·75	14613	·75	19466
·70	1123	·70	3914	·70	7037	·70	10584	·70	14687	·70	19555
·65	1167	·65	3963	·65	7093	·65	10648	·65	14761	·65	19644
·60	1211	·60	4012	·60	7148	·60	10711	·60	14836	·60	19733
·55	1255	·55	4061	·55	7204	·55	10775	·55	14910	·55	19823
29·50	1300	26·50	4110	23·50	7259	20·50	10839	17·50	14985	14·50	19914
·45	1345	·45	4160	45	7315	·45	10903	·45	15060	·45	20004
·40	1389	·40	4210	·40	7371	·40	10967	·40	15135	·40	20095
·35	1434	·35	4260	·35	7427	·35	11031	·35	15211	·35	20186
·30	1478	·30	4309	·30	7483	·30	11096	·30	15286	·30	20278
·25	1523	·25	4359	·25	7539	·25	11160	·25	15362	·25	20370
·20	1568	·20	4409	20	7596	·20	11225	·20	15438	·20	20462
·15	1613	·15	4459	·15	7653	·15	11290	·15	15515	·15	20554
·10	1658	·10	4509	·10	7709	·10	11355	·10	15591	·10	20647
·05	1703	·05	4560	·05	7766	·05	11421	·05	15668	·05	20740
29·00	1748	26·00	4610	23·00	7823	20·00	11486	17·00	15745	14·00	20833
28·95	1793	25·95	4660	22·95	7880	19·95	11552	16·95	15822		
·90	1839	·90	4711	·90	7937	·90	11618	·90	15900		
·85	1884	·85	4762	·85	7995	·85	11683	·85	15977		
·80	1929	·80	4812	·80	8052	·80	11749	·80	16055		
·75	1975	·75	4863	·75	8109	·75	11815	·75	16133		
·70	2021	·70	4914	·70	8167	·70	11882	·70	16212		
·65	2066	·65	4965	·65	8225	·65	11949	·65	16290		
·60	2112	·60	5016	·60	8283	·60	12016	·60	16369		
·55	2158	·55	5067	·55	8341	·55	12082	·55	16448		
28·50	2204	25·50	5119	22·50	8399	19·50	12149	16·50	16527		
·45	2250	·45	5170	·45	8457	·45	12217	·45	16607		
·40	2296	·40	5222	·40	8516	·40	12284	·40	16687		
·35	2342	·35	5274	·35	8575	·35	12352	·35	16767		
·30	2388	·30	5325	·30	8633	·30	12420	30	16847		
·25	2435	·25	5377	·25	8692	·25	12487	·25	16927		
·20	2481	·20	5429	·20	8751	·20	12556	·20	17008		
·15	2528	·15	5481	·15	8810	·15	12624	·15	17089		
·10	2574	·10	5533	·10	8869	·10	12693	·10	17170		
·05	2621	05	5585	·05	8929	·05	12761	·05	17252		
28·00	2667	25·00	5638	22·00	8988	19·00	12830	16·00	17334		

LATITUDE.

−		+
45	0·0000	45
50	0·0005	40
55	0·0009	35
60	0·0013	30
65	0·0017	25
70	0·0021	20
75	0·0023	15
80	0·0025	10
85	0·0027	5
90	0·0027	0

XXXVIII.—On the Construction of the Atlantic Cable.

By Mr. Harry N. Draper.

[Read before the Royal Dublin Society, February 23, 1865.]

Having by the kindness of Mr. Chatterton, Engineer to the Gutta Percha Company, obtained specimens illustrating the construction of the New Atlantic Telegraph Cable, I have taken the opportunity of bringing them before the notice of the Society.

I am not about to occupy the time of the Society by any detailed paper on the subject, but would, in placing the specimens before you, just call attention to the leading features of the new Cable, and the particulars in which it differs from that which was first constructed.

The conductor in the new Cable consists of seven copper wires (six wires twisted round a central wire), which, for the purpose of obtaining solidity, is covered with a layer of the mixture known as Chatterton's Compound—consisting I believe of Gutta Percha, India Rubber, and coal tar. The weight of this compound wire or strand is 300 lbs. per nautical mile. The gauge of the single wires is what is technically known as No. 18; that of the entire strand, No. 10.

The insulation is effected by four layers of Gutta Percha, laid on alternately with four thin layers of Chatterton's Compound. The weight of this insulation is 400 lbs. per mile.

The insulated conductor is externally protected by ten iron wires of No. 13 gauge, each of which is covered with five strands of Manilla yarn, saturated with preservative compound, and the whole laid spirally round the core, which has first been padded with hemp, also saturated with the preservative mixture.

The weight of the entire cable in *air* is 35 cwt. 3 qrs. per nautical mile.

Its weight in *water* is 14 cwt. per mile.

Its *Breaking Strain* is 7 tons 15 cwt. It will therefore bear its own weight in eleven miles of water.

The deepest water to be encountered is somewhat less than 2½ miles.

The Cable has, therefore, more than 4½ times the strength necessary for the deepest water to be encountered.

It may not be uninteresting to put in contrast the details of the structure of the old Cable.

In this, also, there were seven wires united into a strand, the weight of which was 107 lbs. per mile. The insulation consisted of three coatings of Gutta Percha, weighing collectively 261 lbs. per mile. The external protection was obtained by eighteen strands, of seven iron wires in each, laid round the hemp-padded core. The gauge of each of these wires was 22½.

The weight of the entire cable was, in *air*, 20 cwt. per mile; in *water*, nearly 13½ cwt. It would therefore bear its own weight in a little less than five miles of water.

Its *Breaking Strain* was 3¼ tons, and it had but little more than twice the strength requisite for the deepest water to be encountered.

You will, however, see much more readily, by actual comparison of the two Cables, the superiority of the new one, which appears indeed to possess all the elements of success. It has a greater conducting power, twice the strength, and half the specific gravity of the old Cable, and approaches indeed more nearly to the simple insulated and hemp-covered conductor which Captain Maury believes to be far preferable to the heavy and cumbrous cables, in which the iron wire sheathing conduces only to offer resistance to the impetuosity of the waves and ocean currents. "The tiny Nautilus," says Maury, "rides out the hurricane, and weathers storms in which the stoutest men of war have foundered;" and in order to make progress in submarine telegraphy, we must proceed upon the principle, that "a slack line in the sea will hold longer than a taut cable."

XXXIX.—NOTES FOR A COMPARISON BETWEEN THE ROCKS OF THE SOUTH-WEST OF IRELAND, AND THOSE OF NORTH DEVON, AND OF RHENISH PRUSSIA (IN THE NEIGHBOURHOOD OF COBLENTZ). By J. BEETE JUKES, M. A., F. R. S.

[Read before the Royal Geological Society of Ireland, May 10, 1865.]

INTRODUCTION.—In the autumn of 1861 I was able, on my return from leave of absence abroad, to spend a few days in examining parts of Devon and Cornwall, with the view of comparing the rocks there with those of the south-western corner of Ireland. I was so much struck with what I saw, that I fully intended to return the next year, and carry on the investigation, but have never been able to fulfil that intention. Last year I saw a little of the Rhenish rocks in the neighbourhood of Coblentz, and was similarly struck with them. I hope, if circumstances allow me, and official duty does not prevent, to be able still to pursue the comparison of the rocks of these localities with our own; but in the meantime think that, if I lay before you a brief account of the observations already made, and the conclusions deduced from them, it may possibly induce other geologists, whose time is more at their own command, to become fellow-labourers in the task.

Briefly stated, this task is to institute a detailed and accurate comparison of the rocks and fossils of the county of Cork with those of Devon and Cornwall, and of both of these districts with the rocks and fossils of Nassau, Rhenish Prussia, and Belgium.

For descriptions of the rocks and fossils of the South-west of Ireland I must refer you to the published Maps, Sections, and Explanations of the Geological Survey; but I will give here a brief abstract of those descriptions.*

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* In the fifth volume of the first series of our "Journal" is a paper of mine, read March 10th, 1852, entitled "Sketch of the Geology of the County of Waterford," in which

The South of Ireland.—The Old Red Sandstone of Wexford, Kilkenny, and Waterford is similar to that of Pembroke and Caermarthen in lithological character, thickness, and position. In South Wales it gets much thicker as it is traced eastwards from Pembrokeshire. In Ireland it thickens towards the west, till in Cork and Kerry it attains a thickness of many thousand feet, and its base is no longer seen.

It is somewhat affected by slaty cleavage even in Waterford; but in Cork and Kerry this becomes so marked, that it often assumes the character of a *clay-slate formation*, the prevailing colours of which are purple and green. Some of these slates are scarcely distinguishable from the Cambrian slates of Wicklow or Caernarvonshire in lithological character. It is, however, absolutely continuous from the city of Waterford to the extreme south-western headlands of Cork and Kerry, so that a man might walk from one end of that tract to the other without ever leaving the Old Red Sandstone, except for about a mile in the valley of the Blackwater, between Lismore and Fermoy, where it dips beneath the Carboniferous Limestone.

The red conglomerates and sandstones of Waterford may thus be seen to be physically continuous with the purple and green clay-slates and sandstones of Cork and Kerry.

The Old Red Sandstone is thrown into numerous large anticlinal and synclinal folds over axes which at first run east and west, but as they are followed westwards curve to the west-south-west. Through the counties of Wexford, Waterford, Kilkenny, Tipperary, and Lime-

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is advocated the retention of the term "Devonian" for all the rocks (including the Old Red Sandstone) between the Silurian and Carboniferous; and it is proposed to take the lowest bed of Carboniferous Limestone as the base of the Carboniferous series, and to consider all below that as "Devonian." I believe I was right in identifying the beds below the Carboniferous Limestone of Waterford with those of Devon, of which I had seen something in company with Professor Sedgwick many years ago, though it was not till 1862 that the true relations of these rocks first struck me.

In the seventh volume of our "Journal" will be found a paper by myself and Mr. Salter, read June 13th, 1855, entitled "Notes on the Classification of the Devonian and Carboniferous Rocks of the South of Ireland." If the word "Devonian" were omitted from that paper, there is nothing else in it which I should wish to change. The line that can be drawn between the red slates and grits in which there are no marine fossils, and the grey slates and grits above them, in which marine fossils occur, was first pointed out by Mr. Andrew Wyley, who was then on the Geological Survey of Ireland. Plants, and I believe the same species of plants, occur in the rocks both above and below that line. The animal fossils are quite distinct. There is, however, one little element of confusion in the use of the term "Yellow Sandstone." In the South of Ireland we have used this term for the upper part of the Old Red Sandstone, the beds immediately *below* the line. I believe that Sir R. Griffith applied it in the North of Ireland to sandstones interstratified with the beds containing Carboniferous Limestone fossils, which would therefore be *above* the line, and perhaps represent our Coomhola Grits. There is, however, no necessity for correlating the North and South of Ireland at present, or for introducing this embarrassing term—"Yellow Sandstone"—into the discussion at all.

rick, and the northern parts of Cork and Kerry, we have the Carboniferous Limestone, with a thickness of one or two thousand feet at least, coming in over this Old Red Sandstone, the two being separated by some beds of black shale, for which the most convenient name is the "Lower Limestone Shale." These black shales are in some places not more than twenty or thirty feet in thickness, in others two hundred or three hundred feet. Beds of flaggy limestone sometimes occur in their upper part, beds of flaggy sandstone sometimes in their lower portion, so as to produce the appearance of a graduation from the Old Red Sandstone into the Carboniferous Limestone. This description of the Lower Limestone Shale will, I believe, apply equally to South Wales and the neighbourhood of Bristol.

The "Lower Limestone Shale" of Ireland also thickens towards the south-west, and is traversed by slaty cleavage, so that its *shales* become *slates*. Even the Carboniferous Limestone itself in the neighbourhood of Cork and Macroom is often so affected by cleavage as to lose its character of a good marble and building stone, and is only useful for making lime. The Coal-measures of Cork and Kerry are as much a *clay-slate formation* as are those of Devon and Cornwall, though they are not anywhere quarried for roofing slate as they are in the West of England.

Near the city of Cork, and the village of Carrigaline, the Carboniferous Limestone still shows itself in the synclinals of the Old Red Sandstone; but the grey slates and grits which intervene between the two are at least a thousand feet thick near Cork, and two or three thousand near Carrigaline.

Farther south, towards Kinsale, these grey slates and grits are certainly five or six thousand feet thick; and they retain that thickness, and a similar lithological character, over all the country to the westward, to the extreme western headlands of Bantry Bay. Throughout all that region there is no Carboniferous Limestone over them; but I now believe, chiefly upon palæontological evidence, that certain patches of black slates, which occur as the highest beds in certain small areas, are the basal beds of the true Coal-measures.

For the great mass of grey and black slates which thus repose on the Old Red Sandstone of the south-west of Cork, Sir R. Griffith's name of *Carboniferous Slate* is very appropriate; while for the grit beds which occur in it, sometimes as single beds of 2 or 3 feet, sometimes as groups of beds of 20 or 30 feet, or 200 or 300 feet, or, as in the far west, 2000 or 3000 feet, I adopted the name of *Coomhola Grits*, from the name of a place in Bantry Bay.

There is no known instance of any local unconformity, or even of overlap, among the beds now spoken of, in all the region south and east of Dingle Bay.

The Dingle Beds.—In the Dingle Promontory, however, there is a total break and unconformability in the great mass of red rocks which intervene there between the Upper Silurian rocks and the Carboniferous Limestone. Beds of yellow and red sandstones, and red and green shales, there rise conformably from beneath the Carboniferous Limestone, with sandstones and conglomerates below them, making a total thickness of two or three (or perhaps four) thousand feet. These spread unconformably across the edges of other red sandstones, and shales, and conglomerates, many thousand (ten or twelve apparently) feet in thickness, which rest on the Upper Silurian rocks, with either an absolute conformity, or a close approximation to it. We have confined the term Old Red Sandstone to the upper mass, which seems to make a conformable base for the Carboniferous Formation, and given the temporary and provisional name of the "Dingle Beds" to the lower mass, which seems to be more physically connected with the Upper Silurian rocks. We are still in doubt whether the lower portion of the red rocks in the Iveragh and Dunkerron promontory, south of Dingle Bay, are the "Dingle Beds" or not. There is a good deal of lithological resemblance between the rocks of the two promontories, but not a perfect identity. Some blood-red shales or slates, which are occasionally conspicuous in the promontory north of the Bay, do not appear, I believe, in that to the south of it. The thick massive grits, to which we have given the name of Glengariff Grits,* are, however, prominent in both.

In the colouring of the Geological Map of Ireland, however, I thought it most prudent simply to colour the two promontories according to the observed facts. In the Iveragh and Dunkerron promontory the upper red beds are certainly Old Red Sandstone; in descending from these we never met with any characters sufficient to enable us to run a lower boundary to this Old Red Sandstone, and we have therefore coloured all the rocks as belonging to that formation. In the Dingle promontory we got a very decided boundary between two unconformable groups, and have given a provisional colour to the lower group as the "Dingle Beds," confining the Old Red Sandstone colour to the upper group. (*See Explanations of Sheets* 160, &c., and *of Sheets* 182, &c.)

Fossils determined by Mr. Baily.—In two of the Explanations of our Maps—namely, that of Sheets 187, 195, and 196 (those which include Cork Harbour), and that of Sheets 192 and 199 (including the head of Bantry Bay), the fossils found in the Carboniferous Slate are discussed by Mr. Baily, and the species and localities catalogued in a way proposed by myself, which will be found to give a good deal of information in a very condensed and convenient form.

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* In introducing the names "Glengariff Grit" and "Coomhola Grit," I have somewhat departed from the usage common among geologists, since I have used them in a lithological rather than a chronological sense. In each case they are peculiar kinds of stone, recognisable in hand specimens. I have never seen the exact variety of sandstone to which we have given the name of "Glengariff Grit," except in the Old Red Sandstone and Dingle beds of the south-west of Ireland. There is also a peculiar lithological character in the Coomhola Grits, which I have never seen except in the sandstones which lie in the Carboniferous Slate.

Contemporaneity of Carboniferous Slate and Carboniferous Limestone.—There will also be found the reasons which induced me lately to come to the conclusion that the Carboniferous Slate was absolutely contemporaneous with the Carboniferous Limestone; mud and silt being deposited in one part of the sea during the same time that limestone was produced in other parts of it, from the *débris* of the hard parts of marine animals, and especially from the growth of submarine forests of encrinites. I now believe that the Carboniferous Limestone and the Carboniferous Slate equally repose on the Old Red Sandstone, and were equally covered by the Coal-measures resting conformably upon them. The Diagram, Fig. 1, will show what I believe to have been the original relations of the rocks; but this must be taken as a mere diagram, and not as an attempt at a representation of nature, because, to say nothing of the distortion in length, the Carboniferous Slate becomes at least twice as thick as the Carboniferous Limestone. All the beds, both in this and all other geological sections, should be drawn as a mere assemblage of cakes thinning out and terminating in all directions, if it were wished to represent them as they are in nature.

Fig. 1.

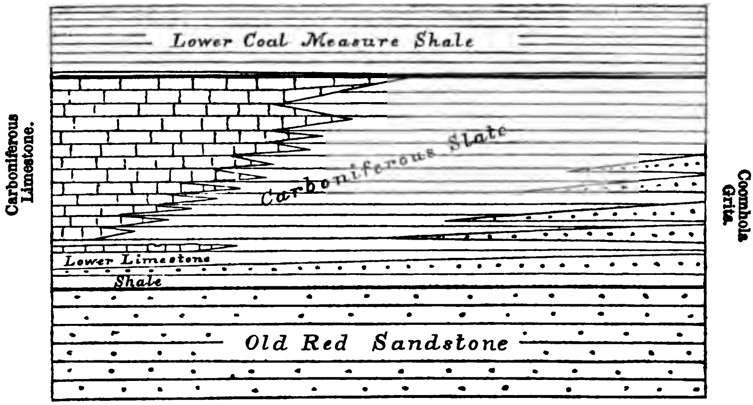

Diagram to represent in a condensed form an ideal restoration of the rock groups of the South-west of Ireland, as originally deposited. In order to afford an approximate representation of the actual beds on the natural scale, this figure, retaining its height, should be extended to a length of about eight or nine feet.

Supposing the general contemporaneity of the Carboniferous Slate with the Carboniferous Limestone to be proved, it becomes very interesting to know how far the rocks of Devon and the Rhine agree with those of Cork.

North Devon. *Piltown and Marwood.*—In August, 1861, I arrived at Barnstaple, and spent five days in examining the country about it. I extract the following passages from my note-book, describing the first day's traverse from Barnstaple northwards:—

"On the road to Piltown dark grey slate with crinoidal rings, nearly horizontal. On first hill-top in Piltown black slate, with calcareous nodules and bands, and seams of fossils; dip south at 25°; cleavage dips south by east at 68°." "*Rhynchonella pleurodon* and *Fenestella antiqua* abundant; the character of the rock and mode of occurrence of the fossils precisely like the Carboniferous Slate of Cork.

"Going up the hill north of Bradford Mill, grey slates interstratified with thin brownish grits from one to eight inches thick, some very rusty-looking and ochreous; dip south, at 80° to 90°.

"Beyond (to the north of) that, dark blue soft slate again, in which the stratification was not determinable.

"For a mile to the north of that, little cuttings by the road sides, or bare rocks in the roads, showed dark blue or grey slate (black when wet), all apparently dipping south at high angles.

"All the minutest peculiarities of the rocks are precisely like those about Kinsale, Rosscarbery, or Bantry.

"In the lane running north-east, between Shankey Down and Fairleigh, dark blue slate, the bedding of which could only be determined by observing the bands of fossils. They dipped W. 20° S. at 30°, while the cleavage of the slate dipped south-south-east, at 70°.

"Small specimens of *Rhynchonella pleurodon* and stems of *Platycrinus* were abundant, together with small *Orthis* or *Chonetes*.

"In Prexford, and going down to Marwood, greenish and brownish sandstones in thick beds, and mingled clayey and sandy rock, like that about the Yellow Sandstone of the county of Cork, &c.; dip south-south-east at 60°.

"In the wood south of Marwood church one or two quarries in brown and greenish slates, sandstones, and gritstones.

"Some of the grits are so precisely like those of the Kinsale country, that it is really wonderful, especially a very peculiar grit, which I never saw before except in the Carboniferous Slate of Ireland. This is a fine-grained light grey grit, seamed all through with thin undulating surfaces of jet black, shiny, argillaceous matter, along which the grit has a tendency to break up into flat lenticular nodules. There are also brownish grits with a grey base, thickly sprinkled with brown dots, such as we call 'speckled grits' in Ireland. Some are much decomposed and quite brown, others black, breaking like rotten wood, and powdering everything about." "These grits are interstratified with hard, dark, sandy clay-rock, not cleaved into slate." "A thickness of fifty or sixty feet of these beds is exposed, all dipping south 10° west, at 40°; no fossils seen in them."

"Pale greenish-grey slate, with some dark blue bands, crop up about Marwood church, at high angles, from under these sandstones.

"Half a mile north of Marwood church (just south of the W. of Widdin, as engraved on the map), purple slates precisely like those of the Old Red Sandstone of Cork.

"Another half mile farther north, on Swinburn Down, a quarry shows purple, green, and yellow sandstone, very like the beds which form the Yellow (or Upper Old Red) Sandstone in West Cork; no plant remains or other fossils visible. The dip is south, at 80°."

This first day's traverse showed me that in North Devon there existed a series of rocks precisely identical with the rocks of the Southwest of Ireland both in lithological and palæontological character; and that we had here the Old Red Sandstone below, and a great thickness of Carboniferous Slate above, with sandstones in the lower part of it, answering exactly to the Coomhola Grits of Ireland.

A subsequent examination of the country by Braunton, and round Baggy Point on the west, and by High Bray, and what is called in the map Span Head,* and Two Barrow Down, on the east, disclosed similar facts.

The red and green grits that show themselves on the coast about Vention, at the south side of Morte Bay, and the pale lilac grits alternating with grey or green, and sometimes with purple and liver-coloured beds, the grits thick and massive, and interstratified with bands of shale, all cleaved into slate, are precisely like the rocks that may be seen outside the mouth of Glengariff Harbour, or about Bearhaven, or other places in Bantry Bay; or about the Mizen Head, or Skull Harbour, or Toe Head, or Galley Head, or the Seven Heads, on the south coast of Cork.

Taken by itself, that might be of little significance; but on following the rocks round Baggy Point, I found a great series of beds above these red ones, precisely like the beds that lie above the red beds in the county of Cork; greenish and greyish sandstones and grits, interstratified with bands of grey and blue slate, until, after passing over a thickness of about 1500 or 1600 feet of such beds, blue and grey clay-slate alone appeared in long straight reefs and ledges in Croyde Bay, precisely as similar rocks show themselves in so many places along the indented coast of the South-west of Ireland.

A succession of beds of many hundreds of feet in thickness having the same variations of lithological type occurring in precisely the same order, and with similar minute lithological peculiarities, those beds being admittedly *about* the same geological horizon, can hardly be other than the same identical beds.

I must therefore believe that the rocks at Vention are genuine Old

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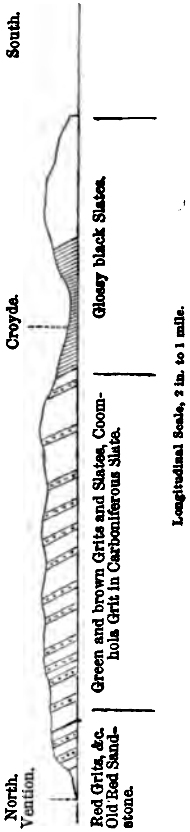
* The hill called Span Head on the Ordnance Map was not so called by the people of the country; and the map altogether was so very indifferent, as to make conclusions as to one's position quite uncertain. When the claims of Scotland and Ireland are quite satisfied, perhaps it may be considered the turn of England herself to have a really good map of the whole country.

Red Sandstone, and that above them we have a great thickness of Carboniferous Slate, with the Coomhola Grits in the lower parts of it.

Fig. 2.

Section from Morte Bay on the north, past the head of Croyde Bay on the south, looking east. The green Grits, &c., form Baggy Point, a mile or two west of the line of section.


North.
Vention.
Croyde.
South.
Red Grits, &c. Old Red Sandstone.
Green and brown Grits and Slates, Coomhola Grit in Carboniferous Slate.
Glossy black Slates.
Longitudinal Scale, 2 in. to 1 mile.

But this conclusion does not rest upon lithological evidence only. At Braunton I was lucky enough to make the acquaintance of Mr. G. A. Symons, a retired Custom House Officer, who occupies his leisure in collecting fossils, so that I was enabled to purchase from him a collection that would have taken me months to form myself. Mr. Symons was good enough also to accompany me to the quarries where he had collected them, and from what I saw with him I had every reason to be satisfied with the accuracy of his statements as to the localities from which they had been collected.

The little north and south valley, at the mouth of which the village of Braunton is situated, affords a pretty good section of the beds by means of a succession of quarries. On the hills on the east side of the village are quarries in beds of grit or sandstone, interstratified with blue slate containing many fossils, the dip of which is about S. 15° W., at 50° to 70°. The cleavage was a little irregular, but in one quarry was noted as perpendicular, striking east and west. Farther north, in the latitude of the little hamlet of Buckland, beds which must be somewhat lower dipped N. 10° E., at 30° or 40°, showing the existence of an anticlinal curve between those two places. There was here a large quarry of dark grey sandy slate and grit, with long stems of fossil plants, compressed by squeezing, precisely like those which occur in the slate rocks of the shore of Mr. Puxley's domain at Castletown Berehaven, in Bantry Bay.

There were also in the same quarries bands of brown sandstone six or eight inches thick, full of the casts of *Cucullæa trapezium*, the rock being often a mere congeries of the impressions of these shells. I think Mr. Symons called these quarries the Kittywell quarries, from the name of a place a little north of them.

Farther north, just north of a place called Knowle, on a new road, there is a large quarry in greenish and grey grits with green slates, which dip south by west at 70°. These are the same grits as those at Marwood, which strike thence in a straight line by Darracott to Baggy Point. They contained at this place a cast of a Curtonotus (of Salter), a

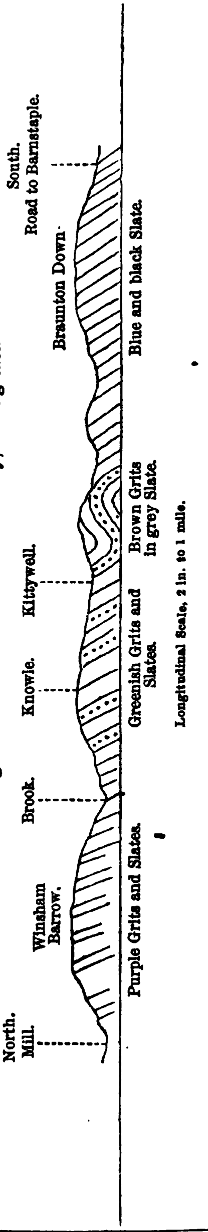


Fig. 3.

Section along the east side of the Braunton Valley, looking east.

Longitudinal Scale, 2 in. to 1 mile.

small Bellerophon, and other fossils, and also part of a (Knorria or) Sagenaria.

The next quarry to the north, at a distance of about a quarter of a mile, showed a purple slate (just like the slates in the Cork Old Red Sandstone), which dipped about south at 80°. Fig. 3 is a diagrammatic section along the east side of the Braunton valley.

Braunton Fossils.—The following is the list of the fossils which I procured from Mr. Symons, the species being determined by Mr. W. H. Baily:—

Plants.

Sagenaria* (Knorria) Veltheimiana.
Sternbergia.

Actinozoa.

Chætetes tumidus.
Petraia Celtica, more properly Cyathophyllum Celticum.
Pleurodictyum problematicum.

Polyzoa.

Fenestella antiqua. | Ceriopora gracilis.

Brachiopoda.

Athyris concentrica, and oblonga or planosulcata.
Chonetes Hardrensis.
Producta prælonga.
Orthis interlineata.
Rhynchonella cuboides, laticosta, and pleurodon.
Spirifera cuspidata, disjuncta, striata, and Urii.
Streptorhynchus crenistria.
Strophalosia caperata. | Strophomena analoga.

Conchifera.

Avicula Damnoniensis.
Aviculopecten nexilis, polytrichus, tesselatus, transversus.
Cucullæa amygdalina, Hardingii, and trapezium.

Cypricardia sp.	Nucula sp.
Modiolopsis sp.	Sanguinolites sp.

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* This was from a place near Knowle, where the sandstones were beginning to become red.

Gasteropoda.

Acroculia vetusta.
Loxonema rugifera.

Heteropoda and Cephalopoda.

Bellerophon subglobatus.
Orthoceras undulatum.

Echinodermata.

Actinocrinus polydactylus and tenuistriatus.
Cyathocrinus pinnatus and variabilis.
Poteriocrinus sp.
Protaster, two species.
Rhodocrinus sp.

Crustacea.

Phacops granulatus and latifrons.

Ilfracombe Beds.—Of the beds still further north, which rise out below the red slates and sandstones, I cannot say much, as I only traversed them once, along the road from Barnstaple to Ilfracombe. I met, about five miles north of Barnstaple, with pale green grits and pale lilac and grey slates, the cleavage of which dipped south at 70°, not unlike those which appear in some of the anticlinal ridges of the county of Cork, where the Old Red Sandstone (all cleaved into slate) rises from underneath the Carboniferous Slate; and it appeared, certainly, as if the main dip of the beds was to the south, at high angles. On the road between Warmscombe and Wincham, however, pale green slate appeared to undulate towards the north, sometimes at as much as 30°, the cleavage still dipping south at 50°.

At Ilfracombe itself, grey, brown, and salmon-coloured sandy slates dip south, with contortions. Some of the smaller bands of bluish-grey slates are undistinguishable from those in the Carboniferous Slate, and do not resemble any which I remember to have seen among the slates of the Old Red Sandstone of Ireland. Nevertheless, except in this and in the absence of dark red or purple colours, the grits and slates are not so very unlike those which the Old Red sometimes presents in the county of Cork, and some beds even reminded me of Glengariff Grits.

I did not see the trace of a fossil anywhere to the northward of the red band that runs from Morte Bay by Winsham Barrow, Mid Marwood, Muddiford, and thence to Span Head, and Two Barrow Down. Fossils, however, have been procured from Ilfracombe, Combe Martin, and Linton, some of them being of the same species as those from the Carboniferous Slate; and if it can be shown that the beds of the north coast are really below the red beds of Morte Bay, then North Devon will disclose facts which have no parallel in the South-west of Ireland.

I must say, however, that I do not feel perfectly satisfied, from what I saw, that the rocks about Ilfracombe and the north coast are really below the Old Red Sandstone beds of Morte Bay. In the paper by

Professor Sedgwick and Sir R. I. Murchison, "On the Physical Structure and Older Stratified Deposits of Devonshire," in vol. v. of the "Transactions of the Geological Society of London" (2nd series), the rocks are described as much contorted, and the section given shows the difficulty of deciding on this point, and also that a large thickness of rocks certainly roll over and dip to the north. In the colouring of the section, indeed, this anticlinal curve and northern dip along the northern coast is confined to the lowest group, which are probably the "Morte slates" and beds below them; but from the difficulty and obscurity of the ground, it seemed to me quite possible that the higher beds are also brought in. The mention of the fossils also found in the rocks of the north coast from Ilfracombe to Linton in that paper, and those described by Professor Phillips in the "Palæozoic Fossils of Devon and Cornwall," induce in my mind a suspicion that possibly the beds of Linton, Combe Martin, and Ilfracombe may belong to the Carboniferous Slate rolled in to the north by contortions, and somewhat different lithologically from those farther south.

The section given in Sir H. De la Beche's Geological Report does not afford any conclusive evidence against such an opinion, since it follows the line of coast, and shows numerous folds of the beds, and spaces where other contortions may exist, so that no very definite conclusions can be deduced from it.

I mention this suspicion, however, with diffidence, and merely put it forward as one of the points which it remains for future examination to put beyond doubt.

Devon Coal-measures.—Of the beds above the Carboniferous Slate I saw exposures in some of the quarries and cuttings from South Molton, by Swinbridge to Bickington and Bideford. They had many lithological resemblances to the Irish Coal-measures of Cork and Kerry. There are not in Ireland, however, any black limestones like those which occur near the base of the Devon Coal-measures. These black limestones and their associated beds are accurately described in De la Beche's "Geological Report," pp. 102 to 118. Some of the limestones are black and earthy, some rather a calcareous grit than true limestone; but others are quite crystalline, the crystals often showing a circular facet, with a dot in the middle, which betrays their crinoidal origin. The shales associated with them are often so carbonaceous as to stain the fingers. Near Hele I saw black shales weathering white, like those of Ballyheedy, near Ballinhassig, county of Cork, which contain Cœlacanthoid fish and Posidonomya.

In some places near South Molton I observed in the basal shales of the Coal-measures that peculiar banded character and iron-stained colour which is a striking feature in the lower Coal-measure shales (or slates) throughout the South of Ireland, from the county of Cork to the county of Dublin.

At the Culm pit, now working near Bideford, and in the railway cuttings there, the impressions of Stigmaria and other common Coal-measure plants were abundant.

Altogether, judging by analogy with the Irish Coal-measures, I have no doubt of the so-called Culm-measures of Devon being of the age of the genuine Coal-measures of the rest of England, including the Millstone Grit as a mere subordinate member of those Coal-measures.

In the South of Ireland and in Devon the beds which contain the peculiar assemblage of fossils characteristic of the lower Coal-measures (or Millstone Grit) are all shales or slates.

This assemblage consists of the following species (see *Explanations of Sheets* 102 and 112, and the previously cited Explanations of the Irish Geological Survey Maps):—

Calamites and other Plants.
Aviculopecten papyraceus and *variabilis.*
Posidonomya Becheri and *membranacea.*
Lunulacardium (sp.).
Goniatites sphæricus and var. *crenistria.*
Orthoceras Steinhaueri and *scalare.*
Fish scales and bones of the Genera *Cœlacanthus* (?) and *Palæoniscus* (?)

De la Beche, "Report," p. 102, insists on the difficulty of deciding on any boundary line between the "Carbonaceous Group" and that which he calls the "Grauwackè Group," and on the absence of any mark of erosion on the lower group before deposition of the upper, or any unconformity between the two. The patches which rest on the Carboniferous Slate of Cork that are supposed to belong to the Coal-measures, are equally inseparable from them by any want of conformity, or any marked lithological character. On the hypothesis that the Carboniferous Slate of Cork and Devon is the equivalent of the Carboniferous Limestone, this conformable gradation is only what might be expected. The difficulties alluded to in p. 131 of the Report are entirely cleared up by the hypothesis.*

So long as the term Grauwackè was applied to the Carboniferous Slate, or that group was supposed to be older than the Carboniferous Limestone, the occurrence of Coal-measure plants in the "Carbonaceous rocks" of Devon had to be explained by other hypotheses, which, to say the least, are not less violent than the one here suggested.

The section given in Fig. 4 will show with approximate accuracy the lie of the beds on a north and south line through Marwood and Pilton, across the flats and estuary of Barnstaple (which are there about a mile wide), to the village of Hele. Feeling certain of the beds about Hele being the true Coal-measures, both from palæontological evidence and from their similarity to the Coal-measures of the South of Ireland, and equally sure that the beds about Swinham Down are the Old Red Sandstone, I must conclude from this section only that the intermediate beds are contemporaneous with the Carboniferous Limestone.

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* I use the term hypothesis for the sake of those who may still doubt it. I have myself no doubt at all that it is the true interpretation of the facts.

Fig. 4.

Section through Marwood and Pilton, from the Old Red Sandstone to the Coal-measures south of Barnstaple.

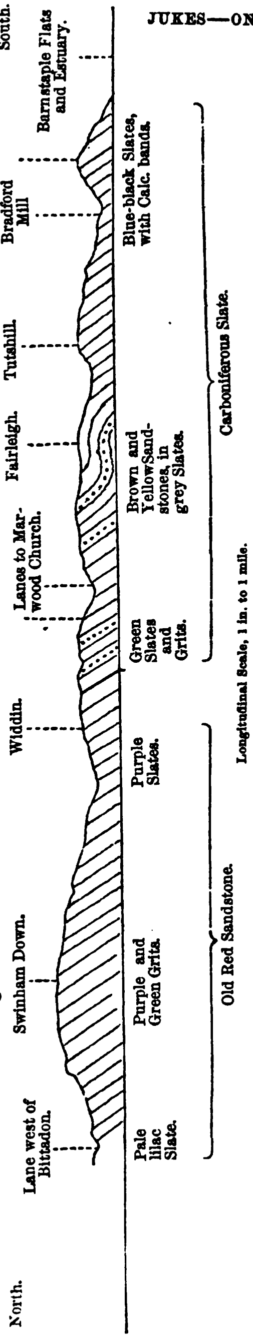
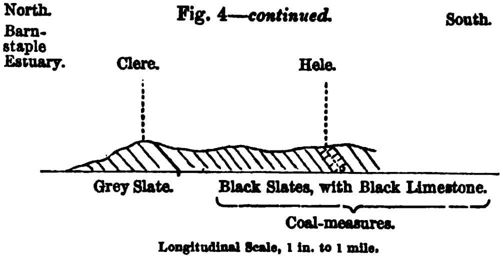


Fig. 4—*continued.*


North.
Barnstaple Estuary.
South.
Clere.
Hele.
Grey Slate.
Black Slates, with Black Limestone.
Coal-measures.
Longitudinal Scale, 1 in. to 1 mile.

General Results.—The great paper on the "Physical Structure of Devonshire," &c., by Professor Sedgwick and Sir R. I. Murchison, in the 5th vol. of the "Transactions of the Geological Society of London," contains conclusions which were a great advance upon those previously taken for granted, and gave us the first approximation towards placing the "Older Stratified Deposits" of that district in their true chronological position. The arguments adduced in it that—"Rocks identical in geological position may entirely change their lithological structure as they pass from one country to another," and that "a change of structure implies a change of conditions during the time of the deposits, and such a change might greatly modify the forms of life" ("Transactions of the Geological Society," vol. v., p. 699), are perfectly sound, and are the very arguments which I would myself urge. The authors of that paper, however, applied them to the hypothesis of a change in the Old Red Sandstone, and I to one in the Carboniferous Limestone. They suppose that the Old Red Sandstone changes into the grey slates of Devon, and also that the Carboniferous Limestone passes into the lower Culm-measures. The hypothesis which I propose leaves the Old Red Sandstone out of the question for the present, and supposes simply a change from Carboniferous Limestone into Carboniferous Slate (which is as likely as into the Culm-measures), and leaves the Coal-measures unchanged, not indeed from their South Welsh type, but from the type which they present throughout the South of Ireland, where they rest upon 2000 or 3000 feet of Carboniferous Limestone.

In a note to page 700, the authors express a hope that their classification may throw light on the structure of the South of Ireland. The result of the Geological Survey of Ireland, however, both by Sir R. Griffith, and by that of the Irish branch of (what I may perhaps be allowed to designate as) Her Majesty's Geological Survey of the United Kingdom, is to point to the South of Ireland as the typical district to which both British and Continental geologists must look for the basis of the true chronological classification of those which have been called Devonian rocks.

It is true that in Ireland we have neither the "Stringocephalus Limestone," nor the Black "Culm-measure limestones." If we class the latter with the Coal-measures, all we can say is, that they are wanting in the South of Ireland, where all the calcareous matter is below the Coal-measures.

I do not at present venture to offer any opinion on the place of the Stringocephalus Limestones; but I do venture to ask, whether there is distinct proof that they are not in the Carboniferous Slate? Can the limestones of Combe Martin and the fossiliferous beds of Ilfracombe and Linton be clearly shown to lie below that group of red slates and sandstones which rises out in Morte Bay, and admittedly rolls over and dips to the north somewhere? Or can the Stringocephalus Limestones of South Devon be shown to lie below anything that can be identified as Old Red Sandstone? Are not the South Devon rocks a mere expansion of the Carboniferous Slate of North Devon, with a change in the *Fauna* depending on difference of *province*, just as the difference between the Fauna of the Carboniferous Slate and the Carboniferous Limestone is one depending chiefly upon *habitat*?

I do not pretend at present to answer these questions, but I would venture to suggest that they have never yet been definitely asked, nor have data been yet collected sufficient to give them a satisfactory answer.

COMPARATIVE LIST OF FOSSILS FOUND IN THE ROCKS OF THE SOUTH-WEST OF IRELAND AND NORTH DEVON.

In drawing up this list of fossils I have adopted the plan used in the "Explanations" of the Irish maps, giving first a numbered list of all the localities from which the fossils were procured, and then appending to each species the numbers of the localities in which it was found. This plan shows the geographical distribution of the species, and the frequency or rarity of occurrence of each, at a glance; and it is easy from it to pick out the number of species found at any one locality—number 30, for instance—as the eye immediately detects the presence or absence of that number under each species. Any amount of detail, too, as to the exact description of any locality, can then be introduced into the list of localities.

The authorities for the specific designations are—for Ireland, Mr. Baily's lists in the Explanations of the Irish Maps, Sheets 187, &c., and 192, &c.,—the species of Brachiopoda having been previously submitted to Mr. Davidson's inspection; for England, the lists in Sedgwick and Murchison's paper, in Phillips's "Palæozoic Fossils," Salter's paper on the "Upper Old Red Sandstone" ("Quarterly Journal Geological Society of London," November, 1863); Morris's Catalogue, and Davidson's Devonian Brachiopoda, in the "Palæontographical Society's Publications;" and the list of fossils procured from Mr. Symons, of Braunton, determined by Mr. Baily.

In drawing up this comparative list I have been advised and assisted by my colleague, Mr. W. H. Baily; for without a professed palæontologist to appeal to, it would be impossible to avoid mistakes.

When fossils occur as mere casts, which is their usual condition in slates and grits, it must often be difficult to determine whether they are specifically different from similar fossils in limestone, or not. This difficulty is increased when the fossils are distorted either by irregular pressure, such as often is apparent in fossils derived from limestone that has been but little altered, as well as from other rocks; or still more when they are distorted in a *quasi*-regular and symmetrical manner, as constantly occurs in rocks traversed by slaty cleavage.

It is not to be wondered at that many erroneous determinations of species have thus been arrived at by able palæontologists; nor is it unlikely that many identical species of shells may still pass under different names in our lists, according to differences in the circumstances of their preservation. When to these circumstances are added the original variation in the size and growth of species of shells according to circumstances that surrounded them during life (their *habitat*, as the botanists phrase it), accuracy of specific determination becomes still more difficult.*

There is, however, another influence which renders lists of fossils very ticklish things to handle, and that is the reform, or at all events the change, which is continually going on in their generic and specific designations.

The old friend of my youth, the *Producta depressa* of the Upper Silurian rocks, passed for many years under the *alias* of *Leptæna*, but has now for some time taken that of *Strophomena*. Shells that I at all events cannot distinguish from the old species, *Producta scabricula*, I find designated as *Strophalosia caperata*, or by some persons *Strophalosia scabricula* (see Salter's paper, "Quarterly Journal Geological Society, London," vol. xix., p. 491). The *Spirifera crenistria* of Phillips's "Yorkshire," is called an *Orthis* in the "Palæozoic Fossils," an *Orthoid* species of *Leptæna* in Morris's Catalogue, an *Orthisina* by Sandberger, but is now decided by Mr. Davidson to be a *Streptorhynchus*. An almost equally puzzling variety of designation takes place among the Conchifera, nor are other classes of fossils much more stable in their nomenclature.

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* We may also add the influence of those intermediate varieties between species and species which the opponents of Darwin's theory confidently demand from geologists, and proof of the existence of which, I think, geologists may as confidently present to them in the long lists of synonyms given in palæontological works, those synonyms being largely made up of what appeared to be distinct species to one set of men, while others class them as varieties of one species.

I do not wish to assume the tone of a censor, or to say that these changes are not improvements, or that it is not necessary that palæontological nomenclature should pass through this transitional metamorphosis before it reaches a stage of comparative permanence; but perhaps I may be allowed to express a hope that we are now approximating to that stage, and that lists of fossils may no longer be written in a language which a few years renders obsolete, as is already the case, not only with the lists in Sedgwick and Murchison's paper, but even with those in Phillips "Palæozoic Fossils," and in Morris's "Catalogue of Fossils."

I have not included among the Devon localities those of Ilfracombe, Combe Martin, or Linton, or any of those in South Devon, but only those lying between the neighbourhood of Baggy Point and that of Dulverton for the Carboniferous Slate, and those between Bideford and Bampton for the Coal-measures, adding to the first the locality of Petherwin in Cornwall.

For the Irish Carboniferous Slate, the localities extend from the shores of Cork Harbour, where some Carboniferous Limestone still exists above the Slate, to the western headlands of Bantry Bay and Kenmare Bay. No species is mentioned which has been found only in the Carboniferous Limestone; nor are any species given on the sole authority of the lists in Sedgwick and Murchison's paper, except the plants from Bideford.

List of Localities.

The localities in Devon and Cornwall are in Roman numerals, to distinguish them from the Irish, and show the species common to the two districts at a glance. The only Cornish locality mentioned is Petherwin, No. XII.

Old Red Sandstone Localities.

1. Kiltorcan, near Ballyhale, in the parish of Knocktopher, county of Kilkenny. The lower beds of this part of the Old Red Sandstone consist of conglomerate resting upon Granite and Lower Silurian slate, and it all dips gently to the west under the Carboniferous Limestone, with a few intervening beds of Lower Limestone Shale between the two. The rock in which the fossils lie is a yellowish-green, fine-grained flagstone, interstratified with bright red slates. Its place is probably 100 or 200 feet below the Lower Limestone Shale, or perhaps a little less or more, the ground not affording the means for a more precise measurement.
2. Tallow Bridge, in the county of Cork, a cutting on the road side, a little east of the bridge, in the topmost beds of the Old Red Saudstone, about its junction with the Lower Limestone Shale (see Fig. on p. 22 of Explanation of Sheet 187 of Irish Maps).
3. Tivoli Villa, Lower Glanmire road, east of the city of Cork; a quarry which is now built over, near the uppermost beds of the Old Red Sandstone, in a greenish stone, like that of Kiltorcan, but traversed by slaty cleavage.

4. Gokane Point and Castlehaven, in the county of Cork, on the shore west of Toe Head, and south-east of Tracarta, in the upper part of the Old Red Sandstone, in beds very similar to those of No. 3, and not unlike those at Kiltorcan, except that they are *all* traversed by slaty cleavage.

4 *a*. Coolownig, half a mile south of Collorus, on the south side of Kenmare Bay, on the road to Castletown Bearhaven.

Carboniferous Slate Localities.

v. Baggy Point, the promontory south of Morte Bay, the extreme western headland of that part of North Devon lying north of Barnstaple or Bideford Bay. The rocks are chiefly grey or greenish grits and brown and yellow sandstones, interstratified with slates. They correspond to the Coomhola Grits of West Cork, which occur in the middle and lower portion of the Carboniferous Slate.

vi. Croyde, a village on the south side of Baggy Point at the head of a little bay, the shores of which show reefs of glossy blue or black slate, the precise equivalent of the more purely slaty portion of the Carboniferous Slate of West Cork.

vii. Saunton, a hamlet, a mile and a half to the E. S. E. of Croyde.

viii. Braunton, a large village, about a mile and a half east-south-east of Croyde, or six miles west-north-west of Barnstaple; the parish includes the upper part of the Old Red Sandstone, and all the Carboniferous Slate except the very topmost beds.

ix. Marwood, a village, four miles east of Braunton and three north of Barnstaple. The same beds of sandstone (lying in the Carboniferous Slate) strike from Baggy Point, by Darracott and Kittywell in Braunton, to Marwood.

ix. *a*. Sloly, a hamlet, three miles north by east of Barnstaple, said by Professor Sedgwick to show sandstones in slates, on the strike of the Marwood beds.

x. Pilton, a village on a small hill, about half a mile north of Barnstaple. The beds are a glossy blue or black slate, with calcareous bands, such as may be seen near Ringabella, outside Cork Harbour, in many parts of Bantry Bay, and throughout the country between them. They are near the upper part of the Carboniferous Slate group.

xi. Brushford, a village, about two miles south of Dulverton, and about twenty-four miles east-south-east of Barnstaple.

xii. Petherwin, a village, about three miles south-west of Launceston, in Cornwall. The rocks are chiefly a pale greenish-grey slate, sometimes calcareous, and containing bands of actual limestone, not altogether so similar to the Carboniferous Slate of Cork as are those of North Devon, but containing many of the same fossils, and undoubtedly part of the same formation. Some blue-black slates were also observed.

13. Bellmount Lower, near Crookstown, seventeen miles west-south-west of Cork; sandstones in the Lower Limestone Shale.

14. Kilpatrick; in Carboniferous Slate.
15. Callatrim, south of Mishells House, a mile and a half north of Bandon; in Carboniferous Slate.
16. Annaghmore, near Cross Barry; a Coomhola Grit in the Carboniferous Slate.
17. Ballinhassig, near the station, about seven miles S. S. W. of Cork; a grit in the Carboniferous Slate.
18. Killaminoge; Coomhola Grits in the Carboniferous Slate.
19. Castlelands, north of Enniskeen, near parochial school; Coomhola Grit.
19*a*. Larah, near Tinker's Cross-roads, two miles W. N. W. of Bandon; in Carboniferous Slate.
19*b*. Coolfadda, a mile and a half west of Bandon, on the road to Enniskeen.
20. On the road to Brookfield, a mile and a half south-east of Bandon; Coomhola Grit.
21. Danganbeg, near Barleigh Bridge, about three miles south of Bandon; grey slate.
22. Cloghane, half a mile west of Rockhouse, between Inishannon and Ballinadee; Coomhola Grit.
23. Lahern, west of Templeavarra Church, south of Inishannon.
24. Mellifontstown, near Ballyvrin Cottage, a mile and a half E. N. E. of Dunderrow; dark grey slate.
25. Ballyfouloo, road-cutting in the glen east of Raffeen House, a mile west of Monkstown, in Cork Harbour; Lower Limestone Shale, consisting of Grits and Slates, at least 1500 feet thick, but with Carboniferous Limestone over them.
26. Monkstown, half way between Monkstown and Raffeen House, west side of Cork Harbour; same beds as 25.
27. Queenstown, cuttings near the Market-house; same beds.
28. Coolkirky, a small quarry in a field, on hill top, on south side of lane to Coolkirky House, between Monkstown and Kinsale; Coomhola Grit.
29. Kilnaglery, near Brookfield, a mile south-east of Carrigaline; Coomhola Grit.
29*a*. Ballea, two miles west of Carrigaline; thick slates, with Carboniferous Limestone above them.
30. Belgooly, near Springmount, in the townland of Lybe, half a mile N. N. W. of Belgooly, which is two miles north by east of Kinsale; dark-grey slate.
31. Gortacluggy, shores of Oysterhaven, opposite Mountlong Castle; grey and black slate.
32. Ringroe, on the shore near Flat Head; black slate with calcareous bands.
33. Ballycottin Bay, to the east of Cork Harbour, on shore; Lower Limestone Shale, like 26 and 27.
34. Timoleague, to the west of the town, which is six miles east of Clonakilty; Coomhola Grit, in Carboniferous Slate.

35. Scartagh, opposite the Union Workhouse, half a mile north-east of Clonakilty; grey slate.
36. Rocksavage, in Ballinglanna Cove, south-east of Clonakilty, on shore; grey and black slate.
37. Dunworly Bay, on the west side; Coomhola Grit, in Carboniferous Slate.
38. Sevenheads Bay, on shore in the townland of Ballymacraheen; Coomhola Grit, in Carboniferous Slate.
39. Old Head of Kinsale, on the shore east of the old Signal Tower; grey slate.
40. Kinsale Harbour, Sandycove; grey slate.
41. Kilkeran, four miles east of Rosscarbery, about a mile and a half north of Kilkeran Lough; Coomhola Grit, in Carboniferous Slate.
42. Duneen Point, west side of Clonakilty Bay; Coomhola Grit, in Carboniferous Slate.
43. Dirk Bay, on shore north of the Coastguard Station; Coomhola Grit, &c.
44. Galley Head, on shore at Castlecove; Coomhola Grit, &c.
45. Bealad, four miles west of Clonakilty; Coomhola Grit, &c.
46. Benduff, two miles north of Rosscarbery; Coomhola Grit, &c.
47. Ahills, two miles west of Union Hall, near Shepperton; Coomhola Grit, &c.
47*a*. Toe Head; Carboniferous Slate and Coomhola Grit, &c.
48. Abbeystrowrey, a mile and a half north-west of Skibbereen; both grits and slates.
49. Mohanagh, two miles north-west of Skibbereen; Coomhola Grit, &c.
50. Killaveenoge West, three miles east of Dromdaleague, on road to Reavouler Bridge, and some other places in the neighbourhood; both slates and grits.
51. Baurnahulla, a mile south-east of Dromdaleague; grey slate.
52. Maunvough, four miles east of Bantry, half a mile south-east of Trawlebane Bridge; grey slate.
53. Seehanes, on the east side of River Ilen, three-quarters of a mile south of Castle Donovan; grey slate.
54. Ballyhalwick, on the road, a mile and a half east of Dunmanway; Coomhola Grit.
55. Shehymore, about the foot of Shehy Mountain; grey and black slates, below Coomhola Grit, and but little above the Old Red Sandstone.
56. Cousane, near the road, half a mile north of Shehybeg Mountain; grey slate.
57. Dromleigh, on the road, about half a mile south-west of Bantry; slates and grits.
58. Relane Point, two and a quarter miles south-west of Bantry; slates and grits.
59. Gorteanish, on the east side of Evanson's Cove, on the north shore of Dunmanus Bay; Coomhola Grit, &c.

60. Reenydonagan Point, two and a half miles north of Bantry; grey slate, with calcareous bands.
61. Reenadisert, on the north-west side of Ballylickey Bridge, three miles north of Bantry; grey slate, with some calcareous bands.
62. Whiddy Island, in Bantry Bay, the north-east point of it; black slate.
63. Ardnaturrish (*more* and *beg*), the shore on the eastern side of the approach to Glengariff Harbour, in Bantry Bay; the typical section of the Coomhola Grit, part of the Carboniferous Slate.
64. Coorycommane, the hill between the entrance to Glengariff Harbour and the Glen of Coomhola; same beds as on Ardnaturrish shore.
65. Coomhola Glen, north of Snave Bridge, at the north-east corner of Bantry Bay; same beds as above.
66. Bear Island, Bantry Bay; numerous localities are here grouped together which are given separately in Explanation of Sheet 192, &c., of Irish Maps; they are all on the northern side of the island, in slates and grits.
67. Black Ball Head—under this designation numerous localities along the shore from the western entrance of Bearhaven past Black Ball Head and White Ball Head, are here grouped together (see Explanation, *loc. cit.*); the Coomhola Grits, interstratified with grey and black slate, strike in full force along this shore.
68. Kilcatherine, the shore about the western extremity of the south side of Kenmare (river or) Bay; Coomhola Grits, in Carboniferous Slate.
69. Ardgroom, various places about Ardgroom Harbour, on the south side of Kenmare (river or) Bay; same beds as preceding.
70. Collorus, the part of the shore to the eastward of Ardgroom; same beds as the preceding.
71. Kilmakilloge, shores of Kilmakilloge Harbour, south side of Kenmare Bay.
72. Lehid, shores about the small harbour of Lehid, north-east of Kilmakilloge; beds probably higher, with calcareous bands.
73. Cloonee, the neighbourhood of Ardea Castle and the Cloonee Loughs, to the eastward of Lehid; Coomhola Grits, in Carboniferous Slate.

Coal-measure Localities.

LXXIV. Swinbridge, a village about eight miles E. S. E. of Barnstaple; black limestone in black slates.

LXXV. Venn, a hamlet, between Barnstaple and Swinbridge; black slates.

LXXVI. Coddon Hill, about two miles south by east of Barnstaple; black slates.

LXXVII. Bampton, a small town, six miles north of Tiverton; black limestones in black slates.

LXXVIII. Westleigh, a hamlet, one mile south of Holecombe Regis, and seven miles north-east by east of Tiverton.

LXXIX. Bideford; the black shales and slates from which culm is extracted in the neighbourhood of that town.

80. Ballyheedy, two miles south of Ballinhassig, between Cork and Kinsale; black carbonaceous shale or slate.

81. Skehanagh, a place a little west of the preceding; same beds as preceding.

82. Meadstown and Ballinphelic, immediately south of Fivemilebridge, between Cork and Kinsale.

83. Lispatrick, on the shore of Courtmacsherry Bay, at the commencement of the promontory of the Old Head of Kinsale; black carbonaceous shales or slates.

NOTE.—The Irish localities mentioned are in small ill-defined patches of black shales and slates, which rest on the Carboniferous Slate, but resemble in the kind of rock the Coal-measure shales or slates which lie above the Carboniferous Limestone further north, and contain similar fossils.

OLD RED SANDSTONE FOSSILS.

Plants.

Adiantites (Cyclopteris) Hibernicus, 1, 2, 4.
Filicites lineatus (linear plants), 4.
Sagenaria (Knorria) Veltheimiana (*Goep.*), Lepidodendron minutum (*Haughton*), 1, 2, 4, 4*a*, VIII.
,, Kiltorkensis (Cyclostigma Kiltorkense of *Haughton*), 1, 4.
Sphenopteris Hookeri (*Baily*), 1.
,, Humphresianus (*ib.* MS.).
Plant stems undetermined, 1, 2, 4, 4*a*.

Undetermined plant stems (some of them Stigmaria-like roots) were also seen in many other localities in the Old Red Sandstone.

Conchifera.

Anodonta Jukesii,[*] 1, 3, 4.

Crustacea.

Eurypterus Scouleri[†] (?) *Hibbert*, 1.

Pisces.

Asterolepis, ? sp., 1.
Bothriolepis, ? sp., 1–4.
Coccosteus decipiens, ? 1.
Glyptolepis microlepidotus, 1.
,, ? elegans, 1.
Pterichthys,[‡] ? sp., 1.

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[*] A fine specimen of this shell was also procured by Mr. Doran from the Old Red Sandstone near Clonmel.

[†] A few fragments only, but sufficient to leave no doubt as to its *genus*, were found in this locality.

[‡] Mr. Baily believes that all these genera are represented by the fish scales, teeth, and jaws from the Kiltorcan quarry. Of the occurrence of the genera Coccosteus and Glypto-

FOSSILS OF THE CARBONIFEROUS SLATE.

[NOTE.—The species which occur in the Carboniferous Limestone of the British Islands, according to Morris's Catalogue, have L before them.]

Plants.

Filicites lineatus, 25, 27, 37, 48, 52, 56, 63, 64, 66, 68, 73.
Sagenaria (Knorria) Veltheimiana,* IX.*a*., 35, 56, 68, 71.
Sphenopteris Humphresianus.

Fragments of undetermined plants, like those of the Old Red Sandstone, some of them perhaps torn leaflets of Ad. Hibernicus, also occur in the lower part of the Carboniferous Slate of Ireland at many other localities. Stigmaria-like roots also occur frequently.

The plants described by Professor Sedgwick from the Coomhola Grits of the Sloly quarries in Devon, are said by Professor Lindley to contain either a *Stigmaria* or a *Lepidodendron*. Mr. Salter speaks of them as *Knorria*, and of their occurrence in green grits in other localities in Devon. Parts of the very same stems at Tallow Bridge, in Ireland, have the appearance of a *Lepidodendron*, while other parts are more like some variety of *Sigillaria*. They are, in the opinion of Mr. Baily, mostly referrible to the genus *Sagenaria*, Brongn.

Pieces of the stem of this plant, which I found in the red rocks north of Braunton, were precisely identical with some which we got in Ireland.

It is probable that all the species of plants are common to the Old Red Sandstone and the Carboniferous Slate.

Actinozoa.

L. Alveolites (Chætetes) depressa, 60.
Amplexus tortuosus, XII.
L. Chætetes tumidus, VIII., 19*a*, 38, 45, 54, 58, 60, 67, 72.
L. Cladochonus crassus, 30.
Cyathophyllum (Petraia†) Celticum, VIII., XI., XII., 14, 16, 19*a*, 24, 30, 60, 67.
L. " cæspitosum, XII.
Fistulipora cribrosa,‡ X., XI.
Pleurodictyum problematicum, VIII., 15, 18, 19*a*, 19*b*, 22, 24, 30, 58, 72.

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lepis there is no doubt. The fish remains occurred—well preserved, but mostly detached—in a little seam, three inches thick, which on the last occasion of our working the quarry was followed out for some distance without the occurrence of any large connected group of scales in their natural position.

* This plant, or those called *Knorria acutifolia* and *confluens* by *Dunker* and *Mayer* (perhaps identical species) occurs in Carboniferous Slate also in Dromleigh, on the road about half a mile south-west of Bantry. W. H. B.

† To this species are referrible other species of "Petraia," and of the genus "Turbinolopsis" of the "Pal. Foss." of Phillips. W. H. B.

‡ Referred to "Manon," in Phil. "Pal. Foss."; but a Fistulipora according to Morris.

Polyzoa.

Ceriopora gracilis,[1] VI., VIII., X., XI.
L. ,, rhombifera, 21, 30, 32, 33, 35, 50, 52, 63, 68.
L. Fenestella antiqua,[2] VI., VIII., X., XI., 15, 19*a*, 27, 30, 32, 52, 55, 58, 60, 61, 63, 66, 67, 68.
Glauconome pluma,[3] 60, 63, 66.
L. ,, bipinnata,[3] VI., X., XI.
L. Polypora laxa,[4] VI., 60, 67.

Brachiopoda.

L. Athyris ambigua, 15, 17, 18, 21, 22, 23, 24, 30, 36, 40, 49, 58, 63, 66.
,, concentrica,[5] V., VIII., X., XI., XII., 36, ? 60, ? 63.
L. ,, lamellosa,[6] 53.
L. ,, planosulcata,[7] VIII.
L. ,, Royssii, ? 60, ? 63.
,, seminalis (n. s., Baily), 63, 66.
Atrypa desquamata, XII.
L. Chonetes Hardrensis, VIII., 36, 60, 67.
" plicatus, X. XI.
Cyrtina heteroclita,[8] 60.
L. Discina nitida, 29.
L. Lingula mytiloides, 56, 58, 61, 63, 66, 68.
L. ,, squamiformis, 33, 56, 63, 66.
Orthis calcar, X.
,, interlineata, VI., VIII., XI., XII.
L. ,, Michelini,[9] 28, 30, 33, 36, 52, 53, 63, 66, 67.
L. Producta prelonga,[10] (?) V. VIII.
L. ,, scabricula, X., XI., 30, 35, 60, 67.
L. ,, semireticulata, 30.
,, n. s., 60.
,, sp. undeterminable, 53, 55.

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[1] Called Millepora in "Pal. Foss." Mr. Baily believes that *C. gracilis* and *rhombifera* are the same species.

[2] With this species Mr. Baily would unite *Retepora flabellata* and *tenuifila* of Phillips's "Yorkshire," and *F. plebeia* of M'Coy, which occur in the Carboniferous Limestone.

[3] Mr. Baily believes these also to be the same species.

[4] Called Fenestella in "Pal. Foss.," and also in Salter's paper.

[5] Given by Phillips as *Spirifera decussata* (Morris).

[6] The *Spirifera squamosa* of Phillips's "Yorkshire" (ib.).

[7] Davidson unites *A. oblonga* with this species.

[8] This specimen was examined by Mr. Davidson, who decided with little doubt that it belonged to this genus and species. The beds in which it occurs at Reenydonagan, in Bantry Bay, are near the top of the Carboniferous Slate, and abound in *Phillipsia pustulata*, with other species common in the Carboniferous Limestone generally.

[9] This is the *Spirifera filiaria* of Phillips's "Yorkshire" (Morris).

[10] Mr. Baily is of opinion that this species is merely another variety of *Producta semireticulata*, var. *Martini*.

Rensselæria stringiceps[1] (?), 30.
Rhynchonella cuboides, VIII.
,, laticosta, V., VIII.
L. ,, pleurodon, V., VI., VIII., X., XI., 14, 17, 19*a*, 20, 22, 26, 29, 30, 32, 34, 35, 36, 37, 38, 42, 45, 47, 48, 49, 50, 52, 55, 58, 60, 66, 67, 68, 72.
,, pugnus, ?47*a*.
L. Spirifera cuspidata, VIII., 14, 18, 19*b*, 29, 46, 47*a*, 51, 58, 67, 68, 72.
,, disjuncta (?)[2] V., VIII., XII., 33, 36, 55, 60, 61, 64.
,, (Spiriferina) ? laminosa, 14, 60, 66.
,, lineata, XII., 33, 60, 66, 67, 68.
L. ,, pinguis, 29*a*.
L. ,, striata, VIII., 16, 18, 19*b*, 28, 29*a*, 30, 32, 33, 36, 46, 47*a*, 49, 60, 66, 67, 68.
L. ,, Urii,[3] VIII., X., XI., XII., 36, 55.
L. Spiriferina cristata (*Schloth*), 17, 30, 60, 61, 67.
" var. octoplicata.
L. Streptorhynchus crenistria, VIII., 15, 18, 19*a*, 19*b*, 21, 29*a*, 27, 29, 38, 50, 51, 55, 58, 60, 66, 67, 68, 72.
Strophalosia caperata,[4] VI., VIII., X., XII.
L. Strophomena analoga, VIII., IX., X., 67, 68.
Terebratula hastata, 19*a*, 10*b*, 22, 29, 58.
Rhynchonella subdentata, XII.

Conchifera.

Avicula Damnoniensis, VIII., IX., 13, 14, 19*a*, 25, 28, 26, 27, 30, 34, 37, 39, 40, 41, 42, 45, 47, 49, 50, 51, 52, 56, 57, 59, 63, 64, 65, 66, 67, 68, 69, 70, 71, 73.
,, exarata, XII.
,, subradiata, XII.
,, undetermined sp., 25, 26, 55, 70.

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[1] Mr. Davidson detected among the Irish specimens submitted to him from this locality some elongated oval casts, approaching in shape to this form. It occurs at Ilfracombe.

[2] According to Mr. Davidson, the so-called species which have been named *Archiaci*, *Barumensis*, *calcarata*, *distans*, *extensa*, *gigantea*, *grandæva*, *inornata*, *Lonsdalei*, *Murchisonianus*, *protensa*, *Verneuillii*, are all synonyms, or varieties of *S. disjuncta*. He holds it to be decidedly distinct from *S. striata*, some varieties of which, however, are certainly so much like some varieties of *S. disjuncta*, that none but a very practised eye can perceive the difference. See the plates of the two species in Davidson's "Brachiopoda."

[3] Mr. Davidson had some doubts as to this species from the Irish localities; but Mr. Baily feels confident of the correctness of the identification. The Devon localities are from Morris's Catalogue.

[4] Mr. Baily and Mr. Salter had previously named some of the Irish specimens as belonging to this genus and species; but Mr. Davidson could not satisfy himself of its occurrence among those specimens which we submitted to him, and believed those which resembled *Strophalosia caperata* to be *Producta scabricula*.

Aviculopecten alternatus, xii.
,, arachnoideus, xii.
L. ,, arenosus? 37, 58.
,, granulosus, xii.
,, nexilis, viii., x., 37.
C. M. ,, papyraceus,[1] 35.
L. ,, plicatus, ? 45.
,, polytrichus, viii., xi.
L. ,, tesselatus, viii.
,, transversus, viii., x., xi., xii.
,, undetermined sp., 35, 39.
L. Axinus (Cypricardia) deltoideus, xii.
,, n. s. (figured in Explanation of Sheet 192), 49.
,, undetermined sp. 35, 37, 43, 65.
Cardiola retrostriata, xii.
Ctenodonta (Pullastra) elliptica, xii.
Cucullæa amygdalina,[2] viii., ix., 19.
,, angusta, ix.
,, depressa, ix.
,, Griffithii[3] (Salter, n. s.), 47, 49.
,, Hardingii, viii., ix., 20, 23, 27, 28, 30, 39, 41, 63, 70, 72.
,, trapezium,[2] ix.
,, unilateralis,[2] ix.
Curtonotus centralis, 19.
,, elegans,[4] ? viii., ? x., 19, 20, 28, 41, 63, 65, 66.
,, ,, var. elongatus, 19, 20, 24, 37, 39.
,, ,, var. rotundatus, 19, 27, 30, 37, 58, 65, 67, 69.
Cypricardia Phillipsii,[5] v.
,, undetermined sp., 39, 65, 67.
L. ? Dolabra securiformis, 66.
,, undetermined sp., 17, 22.
L. Leda attenuata, 58.
Modiola amygdalina, ? xii.
L. ,, MacAdami, 13, 26, 27, 28, 34, 35, 36, 40, 41, 43, 46, 47, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73.
Nucula latissima, x.
,, lineata, v.
,, plicata, v.

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[1] Almost the only known instance of the occurrence of this species anywhere, except in the Coal-measures. J. B. J.

[2] The species marked thus are probably synonyms of *C. Hardingii.* W. H. B.

[3] This fine species is figured in our Explanation of Sheet 192, &c.

[4] Mr. Salter mentions the occurrence of shells of this genus in the Pilton group. I saw casts of some north of Braunton. I have supposed them to be of this species solely because that is the most abundant species.

[5] Occurs in the Lower Limestone Shale, in two localities, in the county of Cork.

Nucula tenuiarata (Sandberger), 67.
,, n. s. (figured Explanation, 192, &c.), 47.
,, undetermined sp., 13, 15, 17, 18, 22, 32, 33, 34, 37, 41.
Orthonota (Cypricardia) semisulcata, xii.
Pterinæa spinosa, xii., ? 49.
,, ventricosa, xii.
Pullastra antiqua, ix., x.
L. ,, bistriata, ? 60.
Sanguinolaria ? sulcata, xii.
Sanguinolites complanatus, x.
,, liratus, x.
L. ,, oblongus, ? 63.
L. ,, plicatus, 43, 48, 66, 67, 68, 71.
L. ,, transversus, 43, 44.
sp., viii., 14, 30, 33, 39, 42.
L. Sedgwickia bullata, ? 26.

Gasteropoda.

L. Acroculia (Capulus and Pileopsis) striata, ? 22.
L. ,, vetusta, viii., 60.
Dentalium, sp., 39.
L. Euomphalus pugilis, 58.
,, serpens, xi., xii.
,, undetermined sp., 67.
Loxonema nexilis, xii.
L. ,, rugifera, viii., xi.
,, sinuosa, xii.
L. ,, tumida, xii.
,, undetermined sp., 13, 47, 49, 67, 70.
Macrocheilus neglectum, ? xi.
,, undetermined sp., 19*a*, 66, 67.
L. Murchisonia angulata, xi., xii.
Natica meridionalis, v.
,, nexicosta, xii.
L. ,, plicistria, ? 51.
,, undetermined sp., 13, 14, 17, 18, 46, 66, 69, 71.
L. Patella retrorsa, ? 55.
Pleurotomaria aspera, x., xii.
,, cancellata, xi., xii.
L. ,, expansa, v.
,, gracilis, v., xi.
,, undeterm. sp., 18, 22, 37, 39, 40, 51, 58, 66.
Vermetus (Pleurotomaria) antitorquatus, xii.

Heteropoda.

Bellerophon bisulcatus, xii., 39, 47.
L. ,, decussatus, ? 58.

L. Bellerophon striatus, 22, 23, 50, 51, 67, 69.
,, subglobatus, viii., ix., x., 13, 19*a*, 26, 31, 34, 36, 37, 46, 47, 49, 50, 51, 54, 57, 58, 60, 67.
,, trilobatus, ? (probably a form of bisulcatus), xii.
L. ,, Urii, v., x., 13.
,, undeterm. sp., 15, 17, 22, 40.

Cephalopoda.

Cyrtoceras rusticum, xii.
Clymenia fasciata, xii.
,, lævigata, xii.
,, linearis,[1] xii.
,, plurisepta, xii.
,, sagittalis, xii.
,, striata, xii.
,, valida, xii.
,, undulata,[1] xii.
Goniatites biferus, xii.
,, bisulcatus, xii.

Goniatites insignis, (?)[2] xii.
,, linearis, xii.
L. ,, vinctus, (?)[2] x., xii.
Nautilus megasipho,[3] xii.
L. Orthoceras cinctum, xii., 15.
,, cylindricum, x.
,, imbricatum,[4] ix.
L. ,, fusiforme,[5] xii.
,, laterale,[6] xii.
L. ,, lineolatum, vi.
,, striatulum, xii.

L. Orthoceras undulatum, viii., xii., 25, 26, 35, 42, 50, 51, 66.
,, undetermined sp., 15, 22, 24, 28, 30, 32, 37, 39, 44, 52, 54, 58, 67, 68.

Echinodermata.

L. Actinocrinus polydactylus (probably identical with triacontadac.), viii., 32.
L. ,, tenuistriatus, P. F., viii., x.
L. ,, triacontadactylus, 52, 53, 55, 61, 63, 66, 67, 68.
,, variabilis, (?)[7] 15, 16, 28.
Adelocrinus hystrix,[8] xi., (?) 61.
L. Archæocidaris Urii, 67.
Cyathocrinus macrodactylus, xi.
L. ,, pinnatus, viii., (?) 31.
L. ,, planus, 36, 61, 67.

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[1] Morris unites *linearis* with *undulata*, which latter Salter does not mention in his list. W. H. B.

[2] Morris makes *insignis* a synonym of *vinctus*. Salter retains *insignis*, does not mention *vinctus*, but gives *bisulcatus*, which is not mentioned by Morris. W. H. B.

From the figure in Sedgwick and Murchison's paper, it appears to be the same as *G. Henslowi*, and they refer to that species.

[3] Is this the young of another species? See plate in "Pal. Foss."

[4] *Orthoceras imbricatum* is the name given also to an Upper Silurian species.

[5] Morris makes *O. fusiforme* a *Poterioceras*.

[6] Morris refers this to *undulatum*; Salter retains it.

[7] These are probably identical with *Actinocrinus triacontadactylus*, according to Mr. Baily.

[8] These are probably identical with *Platycrinus*, according to Mr. Baily.

L. Cyathocrinus variabilis,* (probably the same as Actin. variab.), VIII., 15, 16, 27, 28, 29*a*, 37, 40, 43.
Palæaster, n. s., VIII.
L. Pentremites ovalis, XI.
L. Platycrinus lævis, (?) 67.
,, undetermined sp. (joints of the genus Platycrinus are of very frequent occurrence), 31, 32.
Protaster,† n. s., VIII., two sp.; 36, one sp.
L. Poteriocrinus and Rhodocrinus seem to be both represented among the Braunton specimens, according to Mr. Baily.

Crustacea.

Leperditia (Cypridina) subrecta, 25, 26, 58, 65.
Phacops granulatus, VIII., XII.
,, latifrons, VII., VIII., X., XI., XII.
L. Phillipsia pustulata, 60, 62, 67.
Trimerocephalus lævis, XI.

Pisces.

Holoptychius scales, V.

COAL-MEASURE FOSSILS.

Plants.

Asterophyllites foliosa, LXXIX.
Calamites arenaceus, LXXIX.
,, undulatus, LXXIX.
Cyperites bicarinata, LXXIX.
Neuropteris cordata, LXXIX.
,, gigantea, LXXIX.
,, heterophylla, LXXIX.
,, Loshii, LXXIX.
Nöggerathia dichotoma, (?) 80, 81.
Alethopteris (Pecopteris) lonchitica, LXXIX.
Pecopteris muricata, LXXIX.
,, Serlii, LXXIX.
Poacites cocoina, LXXIX.
Sphenopteris acuta, LXXIX.
,, latifolia, LXXIX.
Stigmaria,‡ sp., LXXIX.

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[*] One of the species from Braunton appears to be identical with that from Rocksavage, near Clonakilty. W. H. B.

[†] Parts of the Lower Limestone Shale and of the Carboniferous Slate are so crowded with these minute bodies, that they might be well called Cypridina-slate, like the Cypridinen-schiefer of Germany. J. B. J.

[‡] The list of Bideford plants given above will be found in the Appendix of Sedgwick and Murchison's paper. To the additional occurrence of Stigmaria markings in abundance I can myself bear testimony, inasmuch as it is impossible I could be mistaken in identifying things with which I am so familiar. J. B. J.

Plant stems in undeterminable fragments were also seen seen at 80, 81, and 12.

Conchifera.

Aviculopecten papyraceus, 81.
Posidonomya Becheri, including the varieties called *lateralis, membranacea,* and *tuberculata,* LXXIV., LXXV., LXXVII., 80, 81, 82, 83.
,, vetusta (?), 82.

Cephalopoda.

Goniatites carbonarius (?).*
,, sphæricus var. crenistria, LXXIV., 80, 81, 83.
,, mixolobus,† LXXVI., LXXVIII.
,, spiralis,† LXXVII.
,, spirorbis,† LXXVII.
Orthoceras cylindraceum, LXXIV., LXXV.
,, scalare, 80, 81.

Pisces.

Cœlancanthus sp., 80, 81.
Palæoniscus sp., 81.

I would wish in a few words to direct attention to the main conclusions resulting from this comparative list.

In the true Old Red Sandstone of Ireland no fossils have yet been procured which are not of land and fresh water origin, except the fish (which may be fresh water), and the fragments identified with Eurypterus. No fossils have been procured from the Old Red Sandstone of North Devon, except parts of Sagenaria, or Knorria, as it is sometimes called, and those identical with those common in Ireland.

Of the Carboniferous Slate fossils the plants seem to be the same as those found in the Old Red Sandstone. This would be a fact in favour of considering the true Old Red Sandstone as belonging to the commencement of the Carboniferous Period.

The animal fossils of the Carboniferous Slate show many species common to Ireland and England, and those the most abundant and important species, as *Cyathophyllum (Petraia) Celticum, Pleurodictyum problematicum,* L.‡ *Fenestella antiqua,* L. *Polypora laxa, Athyris concentrica,* L. *Chonetes Hardrensis,* L. *Producta scabricula,* L. *Rhynchonella pleuro-*

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* This is mentioned in Sedgwick and Murchison's paper. It was probably from the Coal-measures near Barnstaple, and from the figure might be an imperfect specimen of *G. crenistria.*

† These may perhaps all belong to the preceding species, according to Phillips's own descriptions in the "Pal. Foss." *G. mix.*, and *G. spiralis* and *spirorbis* have "Dev." attached to them in Morris's Catalogue; but the localities given are, as every one admits, in the Culm-measures, and not in any Devonian formation.

‡ The L prefixed serves to distinguish the known Limestone species.

don, L. *Spirifera cuspidata, disjuncta*, L. *striata* and L. *Urii*, L. *Streptorhynchus crenistria*, L. *Strophomena analoga, Avicula Damnoniensis, Cucullæa Hardingii, Curtonotus elegans*, L. *Acroculia vetusta, Bellerophon subglobatus* and L. *Urii*, L. *Orthoceras undulatum*, L. *Actinocrinus polydactylus, Adelocrinus hystrix*, L. *Cyathocrinus variabilis*. This list might have been largely increased, had it not been for the caution exercised by Mr. Baily in leaving under the head of many genera "species undetermined," which could not be certainly identified with the forms figured by Phillips, or others, though they were most probably the same species.

The palæontological identity of the rocks of the two countries is moreover shown by the fact, that many species which have hitherto only been found in one of the two districts also occur elsewhere in the Carboniferous Limestone; so that we can apply the axiom, that "things which are equal to the same thing are equal to one another."

Of Carboniferous Limestone fossils which occur in the Carboniferous Slate of Ireland, but have not yet been identified from that of Devon, we have *Alveolites* (*Chætetes*) *depressa, Cladochonus crassus, Ceriopora rhombifera, Athyris ambigua, lamellosa*, and ? *Royssii, Lingula mytilioides* and *squamiformis, Orthis Michelini, Producta semireticulata, Spirifera laminosa, lineata*, and *pinguis, Spiriferina cristata, Terebratula hastata, Aviculopecten arenosus* and *plicatus, Dolabra securiformis, Leda attenuata, Modioli Mac Adami, Pullastra bistriata, Sanguinolites oblongus, plicatus*, and *transversus, Sedgwickia bullata, Acroculia striata, Euomphalus pugilis, Natica plicistria, Patella* (?) *retrorsa, Bellerophon striatus, Actinocrinus triacontadactylus* and *variabilis, Archæocidaris Urii, Cyathocrinus planus, Platycrinus lævis* ?, and *Phillipsia pustulata*.

Of Carboniferous Limestone species found in the Slate of Devon, but not yet identified in that of Ireland, we have *Cyathophyllum cæspitosum, Ceriopora gracilis, Glauconome bipinnata, Athyris planosulcata, Aviculopecten tesselatus, Axinus* (*Cypricardia*) *deltoideus, Loxonema rugifera*, and *tumida, Murchisonia angulata, Pleurotomaria expansa, Goniatites vinctus, Orthoceras fusiforme* and *lineolatum, Actinocrinus tenuistriatus, Pentremites ovalis*.

When we add to these Carboniferous Limestone species those marked L. in the list of species common to the two slate districts, the palæontological argument for the contemporaneity of the rocks of both districts with the Carboniferous Limestone seems to me as strong as could possibly be expected in such various deposits.

The occurrence of Trilobites of the genus *Phacops* in the slates of Devon is perhaps the fact most calculated to induce palæontologists to assign a higher antiquity to those deposits; but there is no reason why that genus should not have continued to exist during the Carboniferous Period, where the nature of the sea bottoms and surrounding circumstances were favourable to its longevity.

NEIGHBOURHOOD OF COBLENTZ.

In the sixth volume of the "Transactions of the Geological Society," Professor Sedgwick and Sir R. I. Murchison published a paper "On the Older Deposits of North Germany and Belgium," in which they lay down the basis for a reform in the previously received ideas respecting the age of those deposits, and sketch out the relation between the Rhenish rocks and those of Cornwall and Devon.

They have been followed by many other writers, both British and Continental, among which I would especially mention the work of the brothers Guido and Fridolin Sandberger on the Rhenish Slate System of Nassau ("Die Versteinerungen des Rheinischen Schichtensystems in Nassau"), and Von Dechen's new and admirable Map of Rhenish Prussia, now coming out.

My own personal knowledge of the rocks of the Rhine and Moselle country is confined to hasty observations on a few quarries and cliffs on the banks of those rivers. I passed, however, two or three weeks at Coblentz last autumn; and though I was unable, from temporary ill health, to do more than a little casual work, I believe it will be worth while to record the impressions which that left on my mind, as they might afford a starting point for some fellow-labourer.

In the quarries on the road side by Laubach and Kapellen, two or three miles south of Coblentz, I was struck with the resemblance of the rocks to the Carboniferous Slate and Coomhola Grit of Ireland. The same minute lithological peculiarities (which can no more be recognised from description than that resemblance between two persons which we designate as a family likeness) struck me here, which had formerly impressed me in North Devon.

Some of the beds, however, were not like any I knew in the Carboniferous Slate of Ireland or Devon; and on the black shining surfaces of some other beds I observed the impressions of Posidonomya in great abundance.

If, therefore, it be possible that the Carboniferous Slate is to be found here, it is also possible that beds belonging to the Coal-measures rest upon it, as they do in Ireland and Devon, with no very definite boundary between the two.*

It can hardly, perhaps, be mentioned as a corroboration of this idea, but is still worth noting, that in two places I found thin seams of actual coaly matter sufficiently carbonaceous to stain the fingers, like that which would be called a "coal smut" in Staffordshire, or a "coal rod" in Ireland. One of these places was about a mile north of Kapellen,† and the other on the side of the road which winds up to the Karthauserberg, by a little footpath, with steps, going up to the first fort there.

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* I by no means mean to assert that Posidonomya is peculiar to the Coal-measures, as we get it abundantly in the more earthy (calpy) parts of the Carboniferous Limestone of Ireland.

† Mr. F. J. Foot, of the Geological Survey of Ireland, having made a trip to this district last June (1865), informs me that a two-foot coal was formerly worked near Kapellen; he also brought thence some plant impressions—vague, but just like those often seen in the Irish coal-measures.

The Karthauserberg is a promontory of rocky high land between the rivers Rhine and Moselle, which is not much more than a mile across about Laubach, and runs for about two miles north of that. Its summit is a plain at a height of 300 or 400 feet above the rivers, with steep slopes in all directions towards them, except on the south, where the ground rises still higher towards the Kuhkopf, which is a minor eminence of that hilly region which is called the Hundsruck to the south of the Moselle, and the Eifel to the north of that river.

The northern termination of the Karthauserberg slopes to a plain about a mile wide, which is but little above the level of the rivers, and has evidently been formed by their detritus, their junction having travelled down stream about a mile, in consequence of the accumulation of that detritus under the lee of the Karthauserberg.

The rocks are all violently contorted, dipping in various directions at high angles, but their general inclination seemed to me to be from the high land towards the Rhine on the east, and towards the Moselle on the west. This led me to speculate on the possibility of rocks representing the Old Red Sandstone being found about the axis of the anticlinal, in the direction of the Kuhkopf; and it was accordingly with no small interest that on my last drive across the upland plain of the Karthauserberg I came, at the margin of the higher land, on some quarries in red and yellow sandstone, precisely resembling the upper part of the Old Red, or that which has been called the Yellow Sandstone, of Ireland. These are on the Moselle side of the high land, about half a mile north-east of the village of Lay. The beds dip west and north-west at 55° or 60°, and certainly rise from under the dark slates and grits which appear in the cliffs above the river.

The occurrence of this red and yellow sandstone precisely in the direction where I was speculating on the possibility of its existence, but with little expectation of finding it, may be no more than a chance coincidence. It is, however, one that makes it worth while for any one, who may have the opportunity, to examine the ground about the Kuhkopf more particularly, and see whether there is really any mass of rocks resembling the Old Red Sandstone, and where that mass runs to.*

This investigation would have the greater interest if Mr. Sharpe's identification of the lower subdivision of M. Dumont's "Système Eifelien" with the Old Red Sandstone of England should turn out to be correct. In Mr. Sharpe's paper on the "Classification of the Palæozoic Formations given in Dumont's Maps" ("Quarterly Journal Geological Society, London," vol. ix., 1853, p. 23), will be found an account of this "Système," from which it appears that it consists of the Eifel limestone above, the Eifel fossiliferous schists in the middle, and a group of red sandstones and conglomerates below. This would exactly agree with the Cork sections, where, however, the limestone is the ordinary Carboniferous Limestone. If the identification of the red sandstones and the *Mur du Diable* conglomerate with the Old Red Sandstone, by MM. Rozet, C. Prevost, Delanow, and others, and Mr. Sharpe's support of it, be correct, it will follow that the rocks above are Carboniferous, their fossils differing from those of our Carboniferous rocks, perhaps because they belong to a different Carboniferous *province* from those of Great Britain.

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* Mr. F. J. Foot informs me that red and yellow sandstones show themselves on the north side of the Kuhkopf summit, the surface being covered with their angular *debris*; but he could not find any section in them.

Dumont placed his "Systèmes Ahrien" and "Coblentzien" below the Old Red Sandstone, depending solely, I believe, on palæontological evidence, which may after all be modified by space as well as by time, and thus point to a geographical difference instead of a chronological one.

If we can trace out an Old Red Sandstone base for the Coblentz rocks, it will be a strong confirmation of the opinion I ventured to state in the notes to Mr. Davidson's "Devonian Brachiopoda," p. 43, that the uppermost bed of the "Old Red Sandstone was in existence before the deposition of any of the beds containing marine fossils, to which the name of Devonian has been given;" and that all those beds are mere expansions of the Carboniferous Slate of Ireland and North Devon, and therefore, like it, merely geographical variations of the Carboniferous Limestone.

River Drift of the Karthauserberg Summit.—Before leaving the Karthauserberg, I would direct the attention of geologists to the sands and gravels which lie strewed over the upland plain, and the angular blocks of rock lying scattered about it, belonging to rocks which must be sought *in situ* higher up the respective river valleys. It is evident that the junction of the rivers once took place at this level; and, looking up their respective valleys, the lines of terrace at that level may be seen for some miles in each direction. The flat at the northern foot of the Karthauserberg is an exact reproduction of the flat at the top, formed by the rivers at their present levels, similar sands and gravels, and I believe similar blocks, being strewed over it.* If the country were now to undergo slow elevation, the rivers would begin to cut their beds more rapidly; and eventually the Coblentz flat would be left above them, with steep slopes on each side of it, just as the Karthauserberg is now.

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* In Murray's "Handbook" is the following passage:—"The breaking up of the frost is sometimes attended with danger to the town of Coblentz. In the spring of 1830, the ice on the Moselle came down while the Rhine was still frozen over, and being forced on by the current, while there was no outlet for its discharge, was raised into vast heaps near the junction of the rivers, so as to overtop the stone bridge near the Moselle and the quays along its banks. . . . The water of the Moselle rose so high as to break over the tongue of land on its left bank, threatening destruction to the village of Neuendorff, whose inhabitants took to flight, and it even floated *up the Rhine on the top of the ice as far as Boppart* (ten or twelve English miles). *The fields between the two rivers were covered with ice, and all communication cut off.*"

Ehrenbreitstein Rocks.—On the eastern side of the Rhine the rocks have a general resemblance to those of the Karthauserberg, though I was not so much struck with minor lithological resemblances to beds which I knew in Ireland and Devon.

The Rock of Ehrenbreitstein is made of grits, sandstones, and slates, which dip to the north-west at angles of 60° or 70°. In the little valley of the Mühlthal, at the back of the town of Ehrenbreitstein, a pretty good section may be seen in a series of quarries in beds which rise from underneath those on which the fortress stands. At the mouth of the Mühlthal valley the dip is north-west at 10°; the beds then flatten and roll over, so as to dip south-east at 70°, and then rise again in that direction at angles of 50° and 60°.

I only happened to discover fossils in one locality in a little abandoned quarry on the left-hand side of the road to Niederberg, about half a mile out of Ehrenbreitstein. The rock here was crowded with fossils, and the true stratification was only to be discovered by observing the layers of fossil shells. The rock, a green softish sandstone, splits into irregular plates along lines which are nearly horizontal, and which I took at first for the stratification of the rock, until I observed the real bedding by means of widely-spread layers of fossils, a few inches apart, and dipping north-west at 80°, when I perceived that the splitting of the rock must be due to cleavage.

The fossils procured from this quarry were named from Sandberger by Mr. Baily, and belonged to the following species:—

Chonetes sarcinulatus.
Spirifera macroptera.
Spirigerina reticularis.
„ lepida.
Phacops laciniatus.

The latter was a very fine specimen, and when cleaned was found to be much superior to any figured by Sandberger.

The species did not appear to be numerous, though the individuals were in immense abundance.

Collections of Fossils.—Two gentlemen of Coblentz have collections of the fossils of the neighbourhood, viz.:—Herr Geheimrath Zeiler, and Herr Handtmann, Postmaster, and were so obliging as to exhibit them to me.

There is a fine collection of fossils also in the Museum of Natural History at Bonn; but unfortunately they are arranged zoologically instead of stratigraphically, so that their geological significance could only be arrived at by a longer examination than my time allowed of.

The Work of the Brothers Sandberger.—In the map attached to the Sandbergers' work all the rocks of the neighbourhood of Coblentz* are coloured as belonging to the "Spiriferen-sandstein," and the whole system is classed into,

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* In the margin of Von Dechen's new map the rocks about Coblentz are also called "Coblenz-schichten," and "Alterer Rheinische Grauwacke" of F. Roemer.

III. *Upper Group.*

5. Posidonomyen-schiefer.

II. *Middle Group.*

4. Cypridinen-schiefer. | 3. Stringocephalen-kalk.

I. *Lower Group.*

2. Orthoceras-schiefer. | 1. Spiriferen-sandstein.

I believe that the red sandstones which I saw on the southern border of the Karthauserberg rise from beneath the Spiriferen-sandstein, in which Sandberger includes all the rocks immediately round Coblentz. If those red rocks turn out to be true Old Red Sandstone, it will follow that all these groups belong to the Carboniferous period. I should be inclined provisionally to consider it probable that the Lower and Middle groups of Sandberger should be massed together as the representative of the Carboniferous Slate, the Spiriferen-sandstein being, perhaps, the representative of the Coomhola Grit part of that group. I should look upon the subdivisions of the Carboniferous Slate (whether they be sandstones or limestones, and whatever may be their thickness) as of only local value and importance, and upon the variations in the names of their fossils as arising partly from the different names given to the same species, partly from real *variations* in the *species*, arising either from difference of *habitat*, or difference of *province*, and partly from the coming in of *different species* and *different genera*, depending on the same circumstances.

Should this speculation turn out to be well founded, it will probably follow that the Upper Group, the Posidonomyen-schiefer, will be found to be the representative of the bottom part of the true Coal-measures, that in which the local group of the Millstone Grit lies in the North of England.

On comparing the list of species given in the work of the Sandbergers with the list previously given in this paper, I find the following analogies between them.

Of Carboniferous Slate fossils the Sandbergers enumerate, as found in one of their four lower groups:—Among the Actinozoa, *Amplexus tortuosus*, *Cyathophyllum* (*Lithostrotion*) *cæspitosum*, and *Pleurodictyum problematicum*;—among the Polyzoa, *Polypora laxa*;—among the Brachiopoda *Athyris* (*Anoplotheca*) *lamellosa*, *Cyrtina* (*Spirifera*) *heteroclita*, *Producta subaculeata* (if this be, as I should suppose, a mere variety of *P. scabricula*), *Rensælleria* (*Rhynchonella*) *stringiceps*, *Rhynchonella pugnus*, *Streptorhynchus* (*Orthisina*) *crenistria*, *Strophomena* (*depressa*) *analoga*, *Terebratula elongata*;—among the Conchifera, *Cardiola retrostriata*, *Dolabra*(?) (*Isocardia*) *securiformis*, and *Nucula tenuiarata*; among the Heteropoda, *Bellerophon decussatus*, and the species called *trilobatus*;—among the Cephalopods, *Goniatites biferus* and *mixolobus*; and among Crustacea, *Phacops laciniatus* and *latifrons*. Of Coal-measure fossils they give among the plants *Nœggerathia dichotoma* and *Stigmaria* *ficoides*;—and among the animals *Goniatites crenistria*, and *Orthoceras scalare*, as found in their Posidonomyen-schiefer.

The agreement in species, therefore, of the fossils of the Continental and British localities is as great, perhaps, as could be expected, when we take into account two things—first, that all the fossils have not been examined by the same individual, and that the difference in the nomenclature may be the result, to a very large extent, of what the astronomers call the *personal equation*; second, the influence of geographical distribution, or the difference in the *province* of the two Faunæ. When it is recollected that, according to M. Barrande's "*Parallèle entre les depôts Siluriens de Bohême et Scandinavie*," contemporaneous beds contain multitudes of species of Trilobites without a single species common to the two districts of Bohemia and Scandinavia, the amount of the specific identity of the fossils between these two Carboniferous Slate districts of Britain and the Rhine will appear great. If we compare the peculiar assemblage of genera, and especially of those genera of which fossils are most numerous, the resemblance between the Faunæ of the two districts becomes still more striking. Some resemblance may also be traced in a wider analogy, in the appearance, namely, of large bivalve shells (Conchifera) in the rocks of the two districts, although those of one region belong to the genus *Grammysia*, and those of the other to *Cucullæa*.

Conclusion.—The conclusions I have formed are two: first, that it was a mistake to include under one designation the Old Red Sandstone and the beds containing marine shells to which the name Devonian has been applied; secondly, that these latter are merely geographical representatives of the beds commonly known as the Carboniferous deposits, and chronologically are identical with them. Plainly as I have stated these opinions, however, I hold them as opinions formed solely by observation of facts, more or less clearly seen, to be modified or abandoned as soon as facts of a different tendency can be observed by myself, or adduced by others.

XL.—ON THE CHEMICAL COMPOSITION AND FERTILIZING VALUE OF THE SEWAGE OF DUBLIN. By CHARLES A. CAMERON, M.D., Analyst to THE CITY OF DUBLIN.

[Read before the Royal Dublin Society, January 15, 1865.]

THE Sewage of towns, although hitherto but little used as a fertilizer of the soil, has at least proved the fertile subject of calm discussions, angry controversies, newspaper articles, lectures, scientific papers, pamphlets, reports, commissions, experiments, and even Parliamentary inquiries. The problem,—Can the Sewage of London be utilized? has occupied for the last twenty years the attention of capitalists, engineers, chemists, agriculturists, sanitary reformers, and imperial and civic legislators; but, notwithstanding all that has been said and done relative to this important problem, it still awaits a practical solution.

There are two points in relation to Sewage upon which the public have pronounced a positive and unanimous opinion—namely, the necessity for its complete and expeditious removal from the towns, and the desirability of subsequently turning it to good account by applying it to the soil. Every other aspect of the Sewage question is, however, regarded from different, and in many respects opposite points of view. The engineers are not unanimous as to the best mode of conveying the Sewage from the towns to the points of distribution; the chemists have not accurately determined its composition; and even the agriculturists are not agreed as to the kinds of crops to which this manure is adapted, nor have they decided upon the proper quantities in which, under certain circumstances, it should be applied.

This, then, is the somewhat unsatisfactory condition of the Sewage question at a time when it comes prominently under the notice of the citizens of Dublin. The interest attachable to it is no longer confined to the inhabitants of London and those of a few other cities and towns across the Channel; for a project to utilize the Sewage of Dublin is actually afloat, and its promoters promise to be amongst the first to solve one of the most important social problems of this age. I am no more interested in the success of this scheme than every citizen of Dublin should be; and it is merely the statements in relation to it that have been made public that have led me to prepare a paper on the Sewage of Dublin, which the Council of this Society have kindly granted me permission to read before its Members.

The question as to the practicability of using the Sewage of large towns for manurial purposes has for so long a period been discussed by so many able men, that but little originality need be expected in the present Paper. In fact my chief object in reading it is simply to elicit a discussion by a competent assembly on a subject which is likely before long to affect the ratepayer of this city in a most sensitive, and hitherto very vulnerable, point, namely, his pocket. The gentlemen who propose to apply to a useful purpose the Sewage of Dublin are not, it would appear, disposed to undertake the collection of that article. They propose that it shall be delivered to them at points close to the estuary of the river; and they even go so far as to say to the citizens—we will not give you a farthing for all the Sewage you may give us, unless the profits which may result from its application pay us more than a fair percentage upon the capital embarked in the undertaking; in that case, we will divide our surplus profits with you. In order, therefore, to be in a position to comply with the terms of the Sewage Company, the Corporation must construct two huge sewers, paralled to or beneath the quays. The promoters of the Sewage Company appear to have been advised as to the probable cost of constructing these sewers, seeing that they propose lending to the Corporation for that purpose the sum of £80,000, at 5 per cent. The making of the intercepting sewers may or may not cost that large sum; but no doubt the outlay will certainly exceed £60,000.

The questions, then, which the citizens of Dublin are deeply interested in are—Firstly, is it desirable to prevent, at a cost of from £60,000 to £100,000, the Liffey from continuing to be an open sewer? Secondly, are the facts in relation to the application of Sewage such as would justify a reasonable expectation that the operations of the proposed Sewage Company would prove so remunerative as to be a source of revenue to the Corporation, as well as to the Company? These questions I propose to discuss in this Paper.

SANITARY ASPECTS OF THE SEWAGE QUESTION.

There is no doubt but that in the long run the agricultural and civic interests involved in the question of Sewage will be found to coincide; but the *onus* of taking the first step towards the solution of this problem rests on the authorities of the towns. That agriculture sustains a loss so long as the Sewage of towns is poured into the ocean, is quite true; but that loss is a mere negative evil, whilst the presence of this baneful stuff in the midst of a crowded city is a positive injury to its inhabitants. Are the citizens to tolerate the existence of an evil agent amongst them which annually sends no inconsiderable proportion of them to the grave, simply because those to whom that agent would prove a benefit do not take the trouble of coming for it? To the farmer the aspect of the Sewage question is simply a pecuniary one; and were he never to be supplied with the commodity, he would not, as a rule, be the worse off; but to the citizen the removal of the Sewage is a matter of life or death. I venture to assert, without fear of contradiction, that if this city were thoroughly sewered, and the contents of the sewers prevented from flowing into the river, the Registrar-General would have fewer deaths to record in his mortuary tables. Many of the diseases which prove fatal are the results of breathing an atmosphere rendered impure by exhalation from animal *ejesta*. A considerable proportion of the deaths which annually take place in Dublin proceed from what have been aptly termed preventable diseases. During the year 1864, 6200 persons died in this city, and of these five per cent. at least perished from maladies which the observance of strict sanitary precautions would almost completely exclude from our city. Last year the number of deaths amounted to 2·5 per cent. of the population. The Census Commissioners, in 1861, obtained returns from the registers of the cemeteries and graveyards in and near Dublin. From these returns it was found that there had been buried annually for some years an average of 2·9 per cent. of the residents within the municipal boundaries. As the sanitary conditions of the city have evidently been somewhat amended of late years, this improvement in the state of the public health is easily accounted for; but in this respect much yet remains to be accomplished. If it be true, then, that the perfection of our incomplete sewerage system, and the preservation of the waters of our river from pollution, would annually prolong the lives of two or three hundreds of the inhabitants of this city, then, I say its Corporation would be justified, nay, more than justified, in incurring any reasonable expense in achieving objects of such vital importance. As a proof that I am not exaggerating the malign influence which the exhalations of open sewers exercise upon the public health, I need but refer to the case of Croydon. Some years ago the Sewage of this town was discharged into the River Wardle, the waters of which in consequence became so impure, that persons lower down the river could make no use of it for domestic or other purposes. Under these circumstances, some parties who possessed an interest in the water power afforded by the river instituted proceedings against the corporation of Croydon, with the view of compelling them to allow the river to pass unpolluted through the town. The corporation were defeated; and after numerous unsuccessful attempts to deodorize the Sewage, they were at last obliged to lease 300 acres of land, for the purpose of pouring the Sewage over it, and getting rid of it in that way. They subsequently let the land thus irrigated at a rent of £300 per annum greater than was paid for it by themselves; but, owing to the lawsuits, and to the attempts to deodorize the Sewage by removing in a solid state its fertilizing matters, this practical solution of the Sewage question unfortunately cost the people of Croydon no less than £40,000 for an income of £300 per annum. In one respect, however, and that a most important one, this mode of disposing of their Sewage has been productive of the happiest consequences; for it is stated that the annual death-rate in their town and the adjacent districts immediately after sensibly declined. Here, then, we have the best evidence—that afforded by accurate statistics—to show that the thorough and speedy removal of the Sewage of a town promotes in a remarkable manner the longevity of its inhabitants.

Since the subject of the waste of the excrementious matters produced in towns began to attract public attention, many persons have suggested the complete separation of the liquid and solid *excreta* of men from the fluid which converts them into Sewage. All the attempts—and they have been many and costly—to separate the valuable ingredients of Sewage from the water in which they are in so excessively diluted a condition have failed. Nearly ninety per cent. of the solid matter dissolved in the Sewage cannot be precipitated from it by other than processes so costly as to totally preclude their economic application. But, then, it may be urged—why mix the valuable animal fertilizers produced in the city with so prodigious a volume of water? why deprive agriculture of so useful and so portable a manure? I answer—To the citizen sanitary considerations are primary considerations; it is impossible to remove excrementitious matter from our houses unless by mixing it with abundance of water. I am, therefore, totally opposed to the suggestion so constantly made, to treat our liquid and solid *ejesta* after the manner of the Chinese. In the Celestial Empire, as travellers tell us, altars to Cloacina, at which visitors as well as the inmates may worship, form a conspicuous object in the dwellings of the inhabitants; and certain operations of nature, which in the rural parts of this country are usually performed beneath the shelter of a friendly hedge, are in the "Flowery Land" conducted upon the road sides, and with appliances provided by the nearest farmer. Something like this system of manure preservation is to be found in Belgium; but I believe it will never prevail in these countries, where it is so much opposed to all our notions of sentiment and decency, the tendency of which is to keep such matters as much as possible in the background. It would be far better that every particle of fertilizing matter produced in this city should continue to be discharged into the thankless ocean, rather than that we should revert to the old system of privies and cesspools. It has been suggested that water-closets communicating with sewers should be completely done away with; and that the excrements, liquid and solid, should be received into close vessels containing earth, or some other deodorizing substance. In this way, it is contended by those possessed of that dangerous kind of lore, a little learning, the valuable manure produced in cities may be rendered innocuous and portable. Leaving out of the question such a consideration as the enormous quantity of earth which would be required to supply the wants of the 25,000 houses constituting this city, it may fairly be doubted that such a plan would pay its own expenses. In the city of Manchester the system of cesspools still largely prevails. The Corporation discharge the duty of emptying these cesspools, and at a cost to the city of about £20,000 per annum. Of this large sum about £10,000 are recoverable by the sale of the manure; but still the large deficit of £10,000 remains. I believe, then, that if our Corporation undertook to remove the contents of the privies and cesspools that still remain in the city, they would find their operations in that line anything but profitable. There is no doubt but that the present mode of getting rid of the waste matters produced in Dublin is incomparably superior to the old plan of cesspools; and any one who takes the trouble of studying this question will see that in every city in England in which there is no system of sewers, the rate of mortality is very high. Since the abandonment of the cesspool system in London, the public health in that city has wonderfully improved.

The citizens of Dublin have incurred very heavy pecuniary liabilities in their desire to procure a plentiful supply of pure water; and I have no doubt but that their health will benefit by that display of liberality. But I firmly believe that the question of good sewerage is of greater importance than any that has arisen with respect to the relative qualities of the Vartry water and that furnished by the Canals; and to me it is quite clear that the sanitary state of Dublin must continue defective until every house in it communicates with a great central drain, and the waters of the Liffey pass undefiled through the city.

FERTILIZING PROPERTIES OF SEWAGE.

With respect to the fertilizing value of Sewage, I may say at once, that I am one of those who believe it to be very great, when applied under certain conditions, which I will presently indicate. It has failed to satisfy the expectations of some people, who had previously entertained a high opinion of its efficacy; on the other hand, many who doubted its utility have lately seen good reason to change their opinion. I will now briefly describe the results of the use of Sewage in a few of the places in which it has gotten a fair trial. The Sewage of the old part of the city of Edinburgh has for a long period of time been employed for irrigating meadows; and the grass farm of Mr. Miller, at Craigentinny has for many years been held up as an example of the wonderful fertilizing power of Sewage. This farm consists of 250 acres of land reclaimed from the sea, and which at one time was only worth 4*s.* or 5*s.* an acre. Over this farm the Sewage derived from a district inhabited by 80,000 souls is poured. Nothing save grass is grown; and the amount of the produce which it is stated is annually obtained is almost incredible: three or four, and even six heavy crops have been obtained in one year, and that, too, in a rigorous northern climate. The Craigentinny meadows are let to the dairymen of Edinburgh, at an average rent of £22 per acre. With respect to the disposal of its Sewage, Edinburgh is far more favourably situated than any other large city in the empire; its site being much higher than the surface of the surrounding country, the mere force of gravity conducts its Sewage to the meadows which it irrigates. Formerly about 2000 acres were irrigated by the Edinburgh Sewage, but the spread of buildings and other causes have reduced that number by more than one half.

At Rugby, Sewage has been applied to agricultural purposes for some years past; and Mr. Walker, a gentleman in the neighbourhood, receives the whole amount produced in the town, for which he pays a rent of £50 per annum. In 1861 a committee was appointed by the Royal Commission on the Sewage of Towns to experiment at Rugby. The object was to determine the quantity and composition of grass produced on land, a portion of which was to be manured with Sewage, and another portion to remain unmanured. Fifteen acres were divided into three equal parts—one for grass, to be given to oxen; the second, for grass, on which cows were to be fed; and the third was to be meadowed. Each of these five acre divisions was further subdivided into four plots, one of which was left unmanured, and the others received, respectively, 3000, 6000, and 9000 tons of Sewage; some of the results obtained are tabulated in the following Table:—

Produce given to Oxen.

Plot.	Sewage required per Annum.	Actually applied to end of October.	Total Grass per Acre.				Increase of Grass per 1000 tons Sewage applied.			
			tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.
1	—	—	9	5	3	5	—	—	—	—
2	3000	1872	14	16	3	8	2	19	1	7
3	6000	4423	27	1	0	10	4	0	1	9
4	9000	6153	32	16	3	8	3	16	2	9

On the grass given to the milch cows the effects of the Sewage were still more favourable, as will be seen in the following Table:—

Sewage applied.	Number of weeks the produce kept a Cow.	Gallons of Milk per Acre.	Value of Milk at 8*d.* per gallon.	Value of Milk from increased Produce of 1000 Tons Sewage.
			£ *s.* *d.*	£ *s.* *d.*
—	19	321	10 14 3	5 0 0
1387	40·9	570·7	19 0 6	5 19 10
2804	58·8	820·4	27 6 11	5 16 8
4226	68·9	961·3	32 0 10	5 0 11

In these trials it is shown that the application of Sewage was attended by a very great increase in the produce of grass. "Deducting the value of the milk produced from the grass of the unsewaged from that from each of the sewaged acres, reckoning it at 8*d.* per gallon, it appears that where about 1400 tons of Sewage were applied during seven months, the produce calculated, for each 1000 tons of Sewage actually applied, gave an increased amount of milk to the value of £5 19*s.* 10*d.*; where twice that amount of Sewage was applied, £5 18*s.* 8*d.*; and where three times the quantity, £5 0*s.* 11*d.*" The value of the milk obtained from an acre of unsewaged grass was only £10 14*s.* 3*d.*, whilst from the most highly sewaged grass the value of the milk amounted to no less than £32 0*s.* 10*d.* The Rugby experiments, which were conducted under the direction of Mr. J. B. Lawes—so well known for his invaluable chemico-agricultural investigations—have been considered somewhat unsatisfactory, on the ground that the Sewage was not always applied at the proper time; and Mr. Walker states that the fields were flooded to such an extent as to seriously deteriorate the quality of the herbage. Mr. Lawes admits that the experiments were in some respects so conducted that the results would not appear so favourable to the Sewage as under proper conditions would have been the case; but still the great fact remains, that land abundantly sewaged is capable of producing three times as much milk as the same kind of land when unsewaged.

The Sewage of the small town of Ashburton, in Devonshire, is distributed over the greater part of a valley which lies close to the town. The sewaged portion of the valley lets at the rate of £6 per acre, whilst the rent commanded by the unsewaged field at only £1 per acre.

The Sewage of Mansfield is poured over lands in the vicinity of the town, which in consequence have been raised in value from 3*s.* per acre to £12 per acre.

The Sewage of Carlisle, of Leicester, and of two or three other towns, are applied to the useful purpose of fertilizing the soil; and although pecuniary failures in some instances have arisen through futile attempts to concentrate the Sewage, or to distribute it over too wide an area, still in every case the remarkable manurial power of the article was strikingly exhibited.

On the Continent the Sewage of towns is in several places utilized on a large scale. Some time ago, our Government appointed a Commission, composed of Messrs. Way, Austin, and Southwood Smith, to draw up a report on the system of irrigation followed in the North of Italy. In this report it is stated that the Sewage of the city of Milan is employed in irrigating about 4000 acres of land, situated at a distance of a few miles from the city. Each acre receives annually about 9000 tons of Sewage, in which are contained the *ejesta* of forty persons. This land possesses an extraordinary degree of fertility; and becomes so charged with rich organic matter, that its surface is periodically pared, and the parings used to manure other lands not so favourably circumstanced. A Dr. Chiappa has a farm of 580 acres, near Milan, which is manured with the Sewage of the city. The portion devoted to grass contains eighty acres, yielding annually twenty-two tons of produce per acre. The grass is partly made into hay, partly consumed in the green state, and is found sufficient to maintain 100 cows. It is calculated that the 9000 tons of Sewage applied to each acre are equivalent to £4 8*s*. worth of well decomposed manure; but it must be observed that the Sewage of Milan is commingled with the waters of the River Vettabia, and is consequently much more dilute than the Sewage of Dublin. The conclusions at which these Commissioners arrived were chiefly as follows:—That the experience of the application of Sewage in the neighbourhood of Milan affords a striking illustration of the immense advantage which the command of large quantities of mere water alone confers upon agriculture; that the fertilizing virtues of the water are enormously increased by the addition of Sewage, and by its temperature being raised by its passage through a town; that the health of the population of the districts manured with Sewage is not worse than that of the population of regions in which pure water irrigation is carried on; that, notwithstanding the elevated temperature of Italy, no disagreeably odorous emanations arise from the sewaged fields; and, finally, the Commissioners condemn in very decided terms the folly and extravagance of the British people, who by most expensive arrangements seek to get rid of a manure which ought to be equivalent to the annual importation of many hundred thousand tons of guano.

With respect to the application of Sewage derived from manufactories, public institutions and other large establishments, and villages, there is abundant evidence to show that the general results have been very satisfactory. Alderman Mechi states that the use of Sewage on his celebrated farm at Tiptree Hall proved highly productive and remunerative. The Earl of Essex has constantly employed Sewage manure since, I believe, 1857, and with an extraordinary degree of success. This nobleman states that he has obtained from sewaged meadows the large produce of forty-six tons per acre, whilst from the same quality of meadows which had not been sewaged the produce amounted only to from seven to eight tons. On the Earl of Essex's farm an application of 270 tons of Sewage per acre of mangels produced a yield of forty-three tons, or about double the average produce of that crop in England. Even in the case of market gardens, the use of Sewage has proved profitable. In the number of the "Irish Farmer's Gazette" for August 27th, 1859, Mr. R. O. Pringle gives an interesting account of the results of the application of Sewage at Mr. Niven's celebrated garden farm, Drumcondra, county of Dublin:—" The system of liquid manure which has been adopted at this farm is very simple. At the upper end of the field there is a large tank, which is kept full of liquid manure of the richest description, derived from the High Park Reformatory. Before Mr. Niven got this portion of the ground all the Sewage from that establishment was discharged into an open ditch, and was in fact a great nuisance, as well as likely to prove prejudicial to the health of the inmates. By an arrangement with the managers of the institution, Mr. Niven was permitted to throw pipes across the old ditch, and convey the Sewage into his tank; and some idea of its value will be gathered from the fact, that the consumption of soap alone in the Reformatory is nearly a ton a week, producing an immense quantity of suds, which, with other materials, combine to form a most valuable manure."

At the time of Mr. Pringle's visit, there was a fine crop of Kemp potatoes which had been manured with Sewage only, and which up to the 11th August had furnished eleven and a half tons per acre, a considerable quantity still remaining in the ground. When we consider that market gardens require the largest supplies of manure, and that those in the neighbourhood of London sometimes receive 120 tons of natural manure per acre, I think the case of the garden farm at Drumcondra indisputably proves that Sewage is capable of fully supplying the wants of every kind of crop. This morning I received a letter from Mr. Niven, in which he states that he continues to use the Sewage, in conjunction with a small proportion of stable manure, and that he even applies it to fruit-bearing trees. He says that its effects on the vine and peach trees are "amazing." Here, then, we have a nursery and market garden, consisting of thirty acres, maintained in the highest state of fertility by the Sewage derived from a single establishment, the members of which do not exceed eighty in number.

THE MOST SUITABLE CROPS AND SOILS FOR SEWAGE.

With respect to the kinds of crops to which Sewage is best adapted, it appears to be admitted on all sides that the natural and artificial grasses are those which have hitherto been most benefited by its application. There are, however, on record the results of experiments which go far to prove that Sewage may, under certain circumstances, be usefully applied on tillage farms. As a general rule, the constituents of a manure are rendered more efficacious by dissolution in large quantities of water, because they are thereby certain to be equably distributed throughout the soil, and each of the plants they are intended to nourish will obtain its fair share. The advantages of using manure in the form of a dilute solution are clearly shown in Mr. Ruston's Paper, in the 20th volume of the "Journal of the Royal Agricultural Society of England."

This gentleman obtained a large increase in all his crops—grass, green, and white—by simply applying the manure for each acre mixed with about 4000 lbs. weight of water. As a general rule, however, I believe that Sewage, which is an excessively dilute solution of manure, cannot be employed to any great extent on tillage farms, more especially on those that are not thoroughly drained. Light or medium soils, resting on a sandy subsoil, will be found the best absorbents of Sewage, although their power of retaining its fertilizing ingredients is not so great as that of heavy clays. On stiff clay lands, the chief fault of which is their impertransible nature, large dressings of town Sewage would not be beneficial, nay, would be the reverse. The fluid would rest on the surface, and render the soil so cold, and wet, as to be decidedly injurious to most plants. Land of any kind under cereals cannot constantly be the scene of Sewage irrigation; for during the long period of the year devoted to the preparation of the ground, a dry and easily pulverulent condition of the staple is desirable; and during the ripening of the crop, heat and a very moderate degree of humidity are necessary. It is clear, then, that cereal crops could only be benefited by very moderate doses of Sewage, applied at only certain periods of the year. Still, where Sewage is available, I believe that both white and green crops would be largely served by its use; and if it were in a more concentrated condition than that derived from large towns is, it might be applied during by far the greater part of the year. The use of dilute Sewage on a tillage farm being therefore very restricted, it would be unwise to attempt to supply the tillage farmers of a wide area with the drainage of a city like Dublin. Gas companies often find it unprofitable to lay down pipes to certain districts remote from their works, although their commodity is sold at the rate of 4*s.* to 5*s.* per thousand cubic feet: it would be still more unwise were Sewage utilization companies to attempt the laying down of pipes over a wide district in order to supply an article at the rate of only 1*d.* or 1½*d.* per ton. Grass lands, are in a very different condition with respect to Sewage: they are ready at almost any time for the reception of this manure; and their produce is, within certain limits, proportionate to the amount of Sewage applied.

PROPER QUANTITY OF SEWAGE TO BE APPLIED PER ACRE.

With respect to the proper quantities of Sewage to apply to grass, considerable variety of opinion prevails. Very different estimates have been made relative to the actual quantity which annually flows over the Craigentinny Meadows. Mr. James Hope sets it down at 2000 tons per acre; Mr. Miller states it to be 4000 tons; the late Mr. Austin, C. E., estimated it at 8000 tons; whilst Professor Anderson considers it to amount to 14,000 tons. As these meadows receive the Sewage of a district inhabited by 80,000 persons, Dr. Anderson's estimate is probably the nearest to the truth. It is quite certain that the Edinburgh meadows receive enormous quantities of Sewage, which do not appear to have exercised any peculiar effect on the quality of the grasses grown thereon, except in rendering them exceedingly succulent. This disproves the statement made by certain writers, that large doses of Sewage render the herbage of meadows very coarse and inferior. No doubt, in the case of retentive and undrained soils, continued floodings of either Sewage or pure water would render the herbage coarse; but where provision is made for the moderately rapid passage of the liquid throughout and from the soil, very large quanties of Sewage will not injuriously affect the herbage grown upon it. Several authorities upon this subject contend that moderate dressings of Sewage—from 2000 to 5000 tons per acre, per annum—give in the end better results than excessive applications; whilst Mr. Lawes states in his evidence before the Select Committee on the Sewage of Towns, that if he got it for nothing, he would apply 70,000 tons of Sewage to an acre, or, he adds, "anything you like to give me." Mr. Westwood, late farm bailiff to the schools at Annerley, stated before the committee that he obtained as large a return from two acres of rye grass, to which 1500 tons of Sewage had been applied per annum, as from two other acres which had been manured with between 8000 and 9000 tons. As this witness had been obliged to furnish accurate returns relative to the farm under his management to the Government Inspector, the Select Committee appear to have attached great weight to his evidence. It appears to me that the pouring of 20,000 or 30,000 tons of Sewage over an acre of grass is a useless expenditure of the greater part of the fertilizing matters contained therein; and I have no doubt but that the Craigentinny meadows would yield as good crops as they do at present, were their supply of Sewage curtailed by three-fourths of its amount. The evidence given in the Second Report of the Select Committee on the Sewage of Towns is certainly, on the whole, in favour of light dressings as against heavy floodings.

COMPOSITION AND VALUE OF THE SEWAGE OF DUBLIN.

In relation to the chemical composition and fertilizing value of Sewage, the greatest variety of opinion prevails, especially with respect to the latter point. Some place so low a value as ½*d.* per ton upon the article, whilst others estimate its money value at from 1*d.* to 9*d.* per ton. Sir Charles Fox believes it to be worth 1½*d.* per ton; Dr. Hoffman sets it down at 2*d.*; and Mr. Lawes says that if obliged to take it at all times he would not like to give ½*d.* per ton: whilst Alderman Mechi estimates the value of the water alone for irrigating purposes, at 2*d.* per ton. In 1857, I made several analyses of the Sewage of Dublin, the results of which are published in my work on "Agricultural Chemistry."* From these analyses, I estimated the money value of the Sewage to be somewhat less than 1¾*d.* per ton. It is very difficult to arrive at an accurate knowledge of the composition of the Sewage of a large city, owing to the many disturbing influences which affect it. The rain-fall, the supply of water in each locality, the food of the inhabitants of the district, and the hour at which the article is collected, are all important points, which must be taken into consideration, in estimating the average value of a ton of Sewage. Quite recently I have made an analysis of Sewage consisting of a mixture of no fewer than forty samples, selected at different hours during both day and night, from different sewers at their outlet into the river. I find on comparing the results of this analysis with those obtained in 1857, that there exists a close agreement between them.

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* "Chemistry of Agriculture." Dublin: Kelly, Grafton-street. 1857.

According to the results obtained by my last analysis, 100 tons of the Sewage of Dublin contain the following fertilizing ingredients:—

1st.—In Complete Solution—

	Pounds.				Money Value.		
Nitrogen, ...	16·50	at	£70	per ton	£0	10	3·75
Phosphoric acid, ...	3·85	,,	40	,, ...	0	1	4·50
Salts of Potash, ...	5·12	,,	20	,, ...	0	0	10·97
Salts of Soda, ...	16·63	,,	£1 10*s.*	,, ...	0	0	1·78
Total,	42·10			Total,	£0	12	9·00

2ndly.—Mechanically suspended—

	Pounds.				Money Value.		
Nitrogen, ...	2·48	at	£70	per ton	£0	1	6·60
Insoluble Phosphate of Lime, . .	1·84	,,	8	,, ...	0	0	1·57
Organic matter, ...	14·00	,,	0 10*s.*	,, ...	0	0	0·75
	18·32			Total,	£0	1	8·92
Total,	60·42			Grand total,	£0	14	5·92

The Sewage, the analysis of which I have stated above, was collected on three consecutive days; and I find, by reference to the meteorological tables published in the Registrar-General's Returns of Births and Deaths, that the amount of rain which descended upon these days happened to be the average for the whole year. I think, therefore, that the Sewage examined by me pretty closely resembles the average quality of the article throughout the year.

With respect to the amount of Sewage annually produced in Dublin, I have made the following calculations:—

The present supply of pipe water is about 9,500,000 gallons per day; the average daily rain-fall over the sewered districts is about 5,700,000 gallons. The amount of Sewage, therefore, which passes daily into the sewers is 15,200,000 gallons, or 67,857 tons 2 cwt. 3 qrs. 12 lbs., which at the rate of 14*s.* 5·92*d.* per 100 tons, would have a money value of £491 14*s.* 9·12*d.* From these data it will be found that the Sewage annually produced in Dublin amounts to 24,767,857 tons 3 cwts. 2 qrs. 12 lbs., the money value of which is £179,484 7*s.* 4·8*d.*

I am aware that many persons will consider this estimate of the money value of the Sewage of Dublin to be excessive; but I have simply placed the same value upon its various ingredients as I would do if they entered into the composition of guano, or of other artificial manures. If 100 tons of this Sewage were gradually distributed over an acre of land, under any kind of crop, I believe that it would be good value for 14*s.*; but under ordinary circumstances so large a quantity of Sewage is applied per acre, that a large proportion of its soluble ingredients pass away from the soil. The greater part of the most valuable ingredient of the Sewage—namely, the nitrogen, is in the form of urea. This substance I proved by experiments performed in 1856 (and described in a Paper read before the British Association at their meeting held in this city the year following) to be capable of furnishing nitrogen to plants; but Liebig has since then shown that it passes readily out of the soil—a negative quality, which is a great drawback to its use as a manure. The soil possesses the remarkable property of removing from its solutions such substances as potash and phosphoric acid, which furnish food to plants. When Sewage water is poured over the land, the soil seizes upon and retains the ammonia, phosphoric acid and potash present in it, but allows the urea to pass through. This curious absorptive power of soils has, however, its limits; so that, if an excessive quantity of Sewage be poured over a field, some portion of it, and more especially its urea, will not be permanently retained by the soil. Owing to these circumstances, and to the fact that the Sewage flows at times that it is not required, the actual value of the drainage of this city will not correspond with the theoretical estimate which I have given. If, however, the Sewage be applied to an area of 8000 acres of grass land, its money value will be found to be not much short of £100,000 a year.

The value of the Sewage of a town may be ascertained by other means than the analysis of the article. By determining the actual value of the ejesta of an average unit of the population of a town, and by ascertaining the number of its inhabitants, a pretty close estimate of the value of its Sewage (provided, of course, that all the waste matters pass into drains) may be formed. Unfortunately, however, there are considerable differences of opinion as to the manurial value of the excrements of an individual, averaging all ages and both sexes. Dr. Hoffman and Mr. Witt estimate them at 10*s.* 10*d.* per annum, while Professor Anderson sets them down at 6*s.* Whilst agreeing with Professor Anderson as to the amounts of potash, phosphoric acid, and ammonia, yielded by a unit of the population, I differ from him as to the prices which should be placed on some of these ingredients. Dr. Anderson states that an adult male excretes daily the following quantities of valuable matters:—

Fertilizing Matters.	In Urine.	In Fæces.
	Grains.	Grains.
Nitrogen, ...	214	24
[Equal to ammonia, ...	260	29]
Phosphoric acid, ...	50	25
Potash, ...	45	5

This gives for the total annual production :—

	lbs.
Ammonia,	15
Phosphoric acid,	3·3
Potash,	0·3

"On these substances the value of the whole depends; for, though there are other constituents, their quantity is so small, and their manurial importance so trifling, that they may be left out of consideration. If the valuable matters be taken at the price at which they are sold in guano, then the annual value will be :—

	s.	*d.*
15 lbs. of ammonia, at 6*d.*,	7	6
3·3 lb. of phosphoric acid, at 1½*d.*,	0	5
3 lbs. of potash, at 2½*d.*,	0	7½
Total value,	8	6½

"This estimate, it will be noticed, applies to the excretions of the adult healthy male. Those of the female are less valuable by a fifth; and of children the amount, and consequent value, depends upon their age. In fact, the quantity goes on gradually increasing to the period of maturity, and then again diminishes when the bodily functions become less active, towards the close of life. When the proper allowance is made for these (for which a rather elaborate calculation is required, into the details of which it is unnecessary to enter), it appears that the average value of the substances contained in the solid and liquid refuse for the whole population of both sexes and all ages is almost exactly two-thirds of that above given, or, in round numbers, 6*s.* per head."

From the above it will be seen that Dr. Anderson values ammonia at £56 per ton, and phosphoric acid at £18 per ton. I, however, value ammonia at £70 per ton, and the soluble phosphoric acid in Sewage at £40 per ton. The soluble phosphoric acid in superphosphate of lime and other artificial manures is valued by chemists at a higher rate than this. I also place a value upon the soda salts and the organic matters. Affixing, therefore, a higher value to some of the ingredients of excrements than Dr. Anderson does, I consider the amount annually produced by each individual to be worth 8*s.* In 1861 the population of Dublin within the municipal boundaries amounted to 254,808. A great number of persons residing in the suburbs, but employed during the day in the city, are not included in the census. There are sewers from a few suburban places which empty themselves into the Liffey. We may safely assume, then, that the Sewage of Dublin which flows into the Liffey contains the mixed excrements of 260,000 persons, worth, at 8*s.* per head, £104,000. This sum is, however, far short of the amount which I have already stated I consider the Sewage of Dublin to be worth; but the difference may partly be accounted for as follows:—In 1862 there were within the municipal boundaries 7365 horses, 78 mules, 572 asses, 762 heads of horned cattle (including 602 milch cows), 773 sheep, 7558 pigs, and 1589 goats; total, 18,697 animals. The census of these animals was taken in summer, when the greater numbers of the horned stock belonging to the dairies were pastured in the rural districts. In winter the milch cows are more numerous in the city, and their liquid excrement no doubt improves the Sewage as a manure. The quantity of liquid excrement formed by a cow is at least seven times greater than that voided by a man; and it is almost needless to remark that the ejesta of a horse is much more valuable than that from a man. I am under the mark when I put down the average value of the manure produced from each of the animals above-mentioned at £1 per annum, or a total of £18,697, which, added to the value of the human effete matter, makes up the sum of £122,697. The soap suds, refuse parts of food, and slops of all kinds from private dwellings, the excrements of thousands of dogs, cats, and birds, and the waste matters from manufactories, which find their way into the sewers, must be worth a large sum as manure. We must also take into account the ammonia and nitric acid which are carried down from the atmosphere into the soil, and are found in the Sewage. Even the saline and organic matters contained in the pipe and drainage water, inconsiderable as their amount is when compared with the quantity of pure fluid, come to have no small value when millions of tons of water are dealt with. I venture to say that the potash, soda, and other fertilizing matters contained in 24,000,000 tons of river water, undefiled with sewage, would, if valued at the same rate as if they were constituents of artificial manures, be worth a large sum.

I have endeavoured to show that the estimate which I have made of the value of the Sewage of Dublin, as deduced from the results of my analysis of that fluid, is not very much higher than the estimate based upon the assumed value of the ejesta of the population, and other effete matters produced in towns. Any difference that may exist must be attributed to the difficulty of obtaining an average sample of the Sewage, rather than to the value of the excrements being overstated.

PROBABLE SPEEDY UTILIZATION OF THE SEWAGE OF LONDON AND DUBLIN.

That the public are at length awakened to the fact that they have at their very doors sources of manure rivalling in extent the guano islands of Peru, is evident from the eagerness which capitalists now evince to secure possession of the Sewage of London. One company proposes embarking the colossal capital of £6,200,787; and if granted the use of the whole Sewage of the metropolis, they believe that their undertaking would realize a profit of thirty per cent., a fair proportion of which would be paid over to the Board of Works. The persons who represent this company offer to prove the *bonâ fide* nature of their application by depositing the sum of £60,000 with the Board of Works, on the condition that it should be forfeited if the company fail to fulfil their engagements. Resolutions in favour of this company's scheme were passed during the last year at a great many of the parochial meetings. Another company proposes to convey the Sewage by culvert and embankment to the Maplin Sands in Essex, a distance of forty-four miles. These Sands, it is proposed, should be reclaimed in the ordinary manner, and fertilized by the Sewage. The area to be reclaimed amounts to 12,000 acres, and the cost of the undertaking is set down at £2,000,000. This scheme, which appears to stand well with the Board of Works, deals only with the Sewage of North London. There are several other projects for utilizing the Sewage of London afloat, and there is no doubt but that before long some one of them will be adopted and carried out.

Dublin is more favourably situated with respect to the economic disposal of its Sewage than London. It is nearer the coast, where the land best adapted for Sewage operations is alone obtainable. I am decidedly opposed to the proposal so frequently made to lay down a system of pipes for the purpose of selling the Sewage to farmers. The price obtained for the Sewage, if indeed farmers could be persuaded to purchase the article, would not pay for the cost of its distribution. In fact, the use of Sewage can only yield very satisfactory returns when it is one of the means made use of in the formation of slob lands. At Lough Swilly several thousand acres have been reclaimed from the sea within a very recent period; and the operations have, wherever they were fully completed, realized a good profit. The rent of this slob land varies from 18*s.* to £2 per acre; but some of it is very poor, owing to the want of manure. This is the kind of land which would drink up enormous quantities of Sewage, and produce correspondingly large crops. I believe the company who propose to apply the Sewage of Dublin intend to effect the reclamation of about 2400 acres of sandy wastes, lying between the North Bull Wall and Sutton, and to convert them into dairy farms. I believe this project contains all the elements of success. The reclamation of this slob land would be a profitable speculation *per se;* but when every acre could, by the application of Sewage, be rendered equal in productiveness to ten acres of ordinary land, the operations must in a pecuniary point of view prove very remunerative.

The only advantage which Edinburgh possesses over this city is that its Sewage flows over the irrigated lands by the force of gravity alone. However, the cost of pumping the Sewage of this city up to a height sufficient to give a fall towards the North Bull would not be very great. The trials made with twenty-five Cornish steam-pumping engines in 1851 showed that, on the average, the combustion of one cwt. of coal would by means of these mechanisms raise 1,600,000 gallons of water a foot high. With these data, I calculate that the whole of the Dublin Sewage,* amounting annually to 24,767,857 tons, could be raised to the height of fifteen feet by the combustion of 2580 tons 12½ cwt. of coal, which, at 15*s.* per ton, would cost £1935 9*s.* 4½*d.* This would be only ten per cent. of the value of the Sewage, and would not add materially to the cost of the dressing of each acre. But here I would remark, that the quantity annually produced in Dublin is sufficient to manure at least 8000 acres.

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* Since my Paper was read, I have learned from Messrs. Barrington and Jeffers that Mr. Hemans, the eminent engineer, has already made complete plans for the application of the Sewage. He proposes pumping the Sewage to a height of 18½ feet. There will be no reservoir, only a pumping well. The fall of the Sewage will be 2½ feet per mile to the pumping station, and from thence to the meadows three feet per mile. The floor of the main sewer at the pumping station will be 11½ feet below high-water mark at ordinary spring tides.

EFFECT OF THE AGRICULTURAL APPLICATION OF THE DUBLIN SEWAGE UPON THE PUBLIC HEALTH.

Since the subject of utilizing the Sewage of towns has become a popular one, the question has arisen,—Will the application of Sewage on a large scale injuriously affect the health of the people who may happen to live near the sewaged lands? In the case of a portion of the sewaged meadows near Edinburgh, there is no doubt but that gases, vapours, and putrescent particles are occasionally given off, which are extremely unpleasant to the sense of smell, and certainly are injurious to health. At Lochend and Roseburn the odour, especially during very warm weather, is most offensive; and the winds that constantly blow from either of these places into the city are anything but "balmy breezes." These malarious exhalations arise, however, to a great extent from the open drains through which the Sewage flows. A large proportion of the effete matter produced in the "old town" passes into a stream termed, very characteristically, the "Foul Burn." This stream becomes an open sewer just beyond the eastern side of the town, and during the summer constantly evolves highly fetid gases and vapours. At Craigentinny, which is about two miles from the city, the Sewage is poured over grass land, which speedily drinks it up and completely deodorizes it. I have on three occasions during warm weather visited the sewaged meadows at Craigentinny, and I am enabled to affirm from actual observation that the odour from them is almost inappreciable.

The residents of Clontarf and Baldoyle no doubt feel alarmed at the probability of the Sewage of Dublin being brought close to their doors; but, if the thing be done properly, there will be no real ground for apprehension. The natural destination of the excrements of land animals is the earth, and not the water. If the Sewage of Dublin be brought by means of water-tight conduits to the seaside, and deposited in an absorbent soil, it will not give off miasma.

At present the fæcal matters produced in this city are thrown into the river and bay, in which they slowly decompose, evolving all the while pestiferous vapours. If deposited in the earth, these vapours would not be given off, but would furnish food to plants. No doubt, sewaged lands sometimes emit disagreeable vapours and gases; but that is only when their absorbent and deodorizing capabilities are too highly taxed. In the case of the Edinburgh meadows, from 10,000 to 15,000 tons of Sewage per acre are annually poured over them. Need we wonder, then, that some portion of this fluid remains on the surface to stagnate, and produce miasma! If the Dublin Sewage Utilization Company adopt the plan of moderate dressings—say 3000 tons per acre—I feel quite confident that the scene of their operations will be far less offensive to our olfactory nerves than the strands at Clontarf and Irishtown now are when the tide is out. In any case, the cost of deodorizing the Sewage before its application is not very great: M'Dougall's disinfecting fluid is capable of effecting this, at a cost of only a few pence per 100 tons.

With respect to the purification of the river and the bay, which would result from the application of our Sewage, I need but remark, that the insoluble ingredients in the latter amount annually to about 5000 tons of absolutely dry matter, corresponding to at least 40,000 tons of fetid mud, which at present, like waifs and strays, is tossed to and fro by the tides, discharging fever-breeding gases and vapours into the air.

I fear I have spun out this Paper to an inordinate length, but I trust that the importance of the subject will prove a fair excuse; and, thanking the Council of the Royal Dublin Society for permitting me to bring it under the notice of this meeting, I will conclude in the words of Liebig:—"If clearly understood, and properly managed, the employment of Sewage will prove a blessing to agriculture; and those who by unwearied perseverance have at last seen the consummation of their labours may justly be looked upon as the benefactors of their fellowmen."

NOTE.—The sanitary question arising out of the proposed application of the Sewage of Dublin has excited considerable discussion since the foregoing Paper was read before the Royal Dublin Society. Several very influential persons, connected by ties of property or residence with the districts near which it was proposed to utilize the Sewage of the city, energetically opposed the project. Several eminent medical men, too, expressed very strong opinions relative to the application of the city Sewage to the sands of Clontarf—maintaining that, if such a project were carried into effect, the public health, not only in Clontarf and Baldoyle, but even in Dublin, would seriously suffer thereby. All these opinions were founded upon vague generalities; upon such scientific platitudes as the poisonous nature of the gases given off from putrefying organic matter; and, finally, upon the alleged evil effects of the Sewage irrigation near Edinburgh. With respect to the effects of the Edinburgh Sewage, no conclusion of general application can be drawn from them, because the article is applied in such enormous quantities, that the soil is utterly unable to properly absorb and deodorize it—in fact, the thing is overdone. That, however, Sewage, when properly utilized, does not give off matters injurious to the public health, is evident from a letter which I have recently received from Dr. Sutherland, Medical Officer of Health for Croydon. In order to understand the full significance of Dr. Sutherland's statements, it will be necessary to bear in mind that the estimated population of Croydon (parish) in 1864 amounted to 37,862; the number of houses is 5585, of which 4870 are in connexion with public sewers, the contents of which are used in irrigating 300 acres of grass land close to the town. Dr. Sutherland states:—"I think I can answer your second query with great confidence, that the public health has in no way been injured by the Sewage irrigation." "It is the opinion of all persons here who have paid any attention to the subject, that the irrigation has been very successful in an agricultural point of view, and I can speak most favourably of it as a sanitary measure."

The Bill for Utilizing the Sewage of Dublin, having met with great and unexpected opposition on the part of certain residents at Clontarf and Baldoyle, has been withdrawn for this session of Parliament. I understand, however, that, with some modifications relative to the *locale* of the Sewage irrigation, the Bill will be reintroduced next session, and with every chance of success. The scheme for utilizing the Sewage of London, proposed by Messrs. Hope and Napier, has been approved of by a Select Committee of the House of Lords. This scheme is in principle identical with that brought forward in Dublin by Messrs. Barrington and Jeffers; and, in my opinion, proposes the most feasible and economic means for the useful disposal of large quantities of Sewage.

MR. JAMES HAUGHTON, in the course of some observations, said the question as to Dublin was not so much as to the gathering up of the Sewage, as whether they could secure the condition of giving it to the farmers and others at prices that would enable them to produce the good results from it that had been produced elsewhere. As to the mechanical mode of doing this, Mr. Jeffers might perhaps give them some information. He considered that the large mixture of water with the Sewage was an inevitable circumstance, and that they should now deal with Sewage mixed with water, and make as much of it as they could. He had learned many facts from Mr. George Woods Maunsell, who had personal experience of the matter, with regard to the great results obtained in Edinburgh from the utilization of the Sewage, and the statements laid before the meeting that evening were not at all exaggerated. There were frequently four crops of meadowing in the year taken off those lands. He also referred to the plan proposed in letters, signed "Dixie," in the "Irish Times." The writer had suggested that sewers should be constructed by walls built under the present walls of the River Liffey. But excellent as that project might be in other respects, it was rendered nugatory, in his opinion, by the fact that the channel of the River Liffey was already too narrow, and that there was barely room to turn the steamers.

MR. JEFFERS, of the firm of Barrington and Jeffers, solicitors to the Bill for the Utilization of the Sewage of Dublin, said it was too late that evening to go into the various points raised by the Paper. He read from the evidence of witnesses examined before the Sewage Commission. Lord Essex, who utilizes the Sewage of the town near which he resides in his own demesne, stated in his evidence that in the momentary application of the Sewage to the ground an offensive smell could be experienced, which could be obviated by holding the distributor near the ground; but when the matter was in the ground there was not the slightest smell whatever, and the men who used it never suffered from it. He alluded to this particular point, because he understood that certain parties at Clontarf and Dollymount were afraid that it would injure their house property; that, in fact, they supposed that the odour which was occasionally experienced from the Liffey would be transferred to the green lanes of Clontarf. But no such apprehension need exist. Mr. Way, late chemist to the Agricultural Society of Great Britain, who was examined before the Sewage Committee in 1852, and again last summer, stated that it was in the power of soils to absorb manures, and that "land possesses the power of deodorizing sewage." Dr. Frankland, in reference to the question of the offensiveness of Sewage when applied to land, states that he found the odour disappeared almost immediately after its application; that it was only where it was kept stagnant it became offensive, and that deodorization before applying it to the land was not necessary. He (Mr. Jeffers) hoped that they would be able to succeed in effecting such a very desirable project as the utilization of their city Sewage; and he was anxious that they should succeed in doing so as much for the benefit of the citizens as to show that they were not incapable of inaugurating or carrying out successfully an Irish industrial project.

Colonel Walshe said that at certain stages of the tide there was an offensive odour in the direction of Clontarf, and he did not see how that was to be remedied by the proposed works.

Mr. Jeffers said it had been proved in the evidence from which he had given extracts, that no offensive smell arose from liquid manure being applied to a sandy soil, such as that at Dollymount and Clontarf.

Mr. Carroll said he had had experience in every part of Ireland of the value of liquid manure upon land, and he had no doubt of the success which would attend the proposed undertaking.

Mr. John R. Garstin wished to know from Mr. Jeffers what the expense per acre would be of raising the manure to the requisite height for the purpose of applying it to the lands. Dr. Cameron had told them it would be about £1 per acre for fifteen feet.

Mr. Jeffers said it was purely an engineering question. The calculations necessary to inform them on that point were such as to preclude the possibility of his going into the subject at that hour of the evening. He might, however, state that they had engaged the services of Mr. Hemans, who had been engaged in the work of utilizing the Sewage of London, and he was of opinion that there was not the least practical difficulty in the matter.

The Chairman said that the public at large should feel much indebted to Professor Cameron for his able and interesting Paper on a subject which now engaged the attention of the second city of the empire, and caused great commotion in the capital of the United Kingdom. No question of the present day gave rise to a greater struggle than the utilization of the Sewage of London. There was no difference of opinion that the sanitary condition of a city was to be considered, in preference to those hypothetical ideas as to the value of the Sewage. Chemists made out that there was a certain amount of value in Sewage, and he did not say that was incorrect; but when they found that there was a mixture of water in various proportions, it became a very serious question how they were to get the amount of money which Professor Cameron mentioned. Professor Way, who had been mentioned by Professor Cameron in his Paper, complained before the committee of the use that had been made of his analysis; for it appeared that other chemists took his analyses, and placed their own value on the materials which he obtained. He reprobated that, and took the opportunity of publicly withdrawing these analyses, because he said it was impossible to take any particular sewer. He mentioned that circumstance to show the great difficulty there existed in fixing a value on Sewage. He thought it was quite right that the ratepayers should certainly get the profits of the Sewage; but it should be considered that a very large expenditure must be gone to by somebody in order to make it profitable, and therefore a certain allowance should be made to the parties undergoing that outlay of money. The quantity of grass stated by Professor Cameron to have been raised at Edinburgh by means of Sewage manure was by no means exaggerated. It was enormous. The thing, in fact, was overdone there. The Sewage of that city, containing 180,000 inhabitants, was applied to about 3000 acres of land, and the fact was that the drains through which the stuff flowed were the most abominable things imaginable. Now, the population of Croydon, to which reference has also been made, was but some ten or twelve thousand, and the Sewage of that town was applied to as large an extent of land as that at Edinburgh. There (at Croydon) the application of the Sewage was the most perfect thing that one could possibly conceive. Sewage water in its usual state was black and dirty stuff; but as it is discharged into the neighbouring river at Croydon, it was perfectly clear and pure, and could not be distinguished from spring water. This showed what was capable of being effected by a proper application, in proper proportion, of Sewage to land. He had himself walked over the land thus fertilized at Croydon in company with the engineer of the town, who had kindly explained the whole matter to him, and he did not experience the slightest bad smell. With regard to Manchester, Professor Cameron had put the matter in a very proper light. The cesspool system was maintained there still, and the corporation were obliged to clean the cesspools at great expense. With regard to Rugby, the result of the experiments there, as quoted by the Professor from the Report of the Parliamentary Commissioners, was very extraordinary, and it showed the effect of Sewage upon land. There was no doubt about its producing the results stated. There was great difference of opinion, however, as to the mode in which the application should be conducted. Some parties alleged that it was better to apply the Sewage in streams over the land by means of a jet and hose; but the fact was, the cost of such a process would be so great as to put that entirely out of question. At Milan, also, enormous quantities of Sewage were applied to the land with great results. With regard to the strength of the Sewage of Dublin Professor Cameron had alluded to analyses which he had made, and which he (the Chairman) had no doubt were quite correct; but he was afraid that to come to anything near the truth the samples for analysis should be taken continuously every hour for a long period of time. Though what Professor Cameron said was true—namely, that the Sewage which he took happened to be when there was an average rain-fall there might have been a heavy land-storm two or three days before, which might have cleared all the good stuff out of the sewers, and he might have got a weaker solution than at another time.

PROFESSOR CAMERON observed that the samples he had analyzed were taken on three consecutive days, and that the really valuable ingredients of Sewage do not remain in the sewers, but rapidly flowed out.

THE CHAIRMAN said that in his opinion the samples should be taken out of those sewers at least every two hours for a month or six weeks running. It would be a work of very great labour, but it would be necessary in order to come to any definite conclusion upon the subject. On account of the different elements that entered into the Sewage, it would be a very difficult question indeed to ascertain the exact strength by testing samples taken for a short time. He had already stated that where the Sewage was properly used, as at Croydon, there was no smell whatever. As to the colour of the grass, it was also of great importance in improving it, on account of the water running with it over the land. He did not agree with Professor Cameron in thinking Dublin better adapted for the utilization of Sewage than London, because Dublin was situated on the sea, whereas London was not, and there was a larger fall at London.

PROFESSOR CAMERON.—There is a dead level of several miles in the proposed forty-four miles' drain from London to the Maplin Sands.

THE CHAIRMAN proceeded to say that Professor Cameron had also remarked that he calculated an expenditure of £2000 a year on coals for combustion as sufficient to accomplish the raising of the Sewage to a height of fifteen feet; but the fact was, that to raise it to a height of fifteen feet would be to raise it to high water mark and no higher, and the pumping of it away altogether would increase the expenditure very much. As for the observation of Colonel Walsh, that a strong smell arose from Clontarf sands, he believed that that arose from the decomposition of seaweed, and not from Sewage.

The meeting then separated.

XLI.—Dr. Edmunds' System of Ventilation, for the Purpose of Improving the Sanitary Condition of Ships, and Preserving them from Decay; with Suggestions as to its Applicability for the Purpose of Ventilating crowded Dwelling-houses. By Dr. J. M. Barry, L. R. C. P. D., L. R. C. S. I., M. R. D. S., M. R. Z. S.

[Read before the Royal Dublin Society, April 24, 1865.]

My object in bringing Dr. Edmunds' system of Ventilation under the notice of this Society is, first, because I have experienced its utility in preserving life and promoting health on board the ships of Her Majesty's Emigration Commissioners; and, secondly, because I believe, with very little alteration, the apparatus can be adapted to ventilating the crowded dwellings of the poor, the ill-ventilated rooms inhabited by whom do not materially differ from the confined space allotted to emigrants on board ships during their transit across the pathless deep. With respect to the necessity existing for a better system of Ventilation on board ships than any hitherto devised, we have only to refer to the frightful mortality in crowded passenger ships, arising from typhus, cholera, and dysentery.

In the ships of Her Majesty's Commissioners, in whose service I hold the office of Superintendent, the average mortality during the most unfavourable seasons never exceeded two per cent.

Last year the system of Ventilation I am about bringing under your notice was introduced into the service.

Some of the ships have accomplished the passage without the loss of a life, many of them being altogether free from fever, dysentery, or diarrhœa, the principal sources of mortality at sea. Another satisfactory result is the reduction of infantile mortality.

In some Australian passenger ships I could mention, one-third of the children under five years have died. In the Commissioners' ships fitted with Dr. Edmunds' apparatus, worked by a steam jet, the results have been truly gratifying, some of the vessels—"The General Caulfield," for instance—not losing any children. The system has been introduced into the Royal Navy; and while the mortality in the mercantile marine is three times greater than in the Navy, the mortality in Her Majesty's ships fitted with Dr. Edmunds' system is much less, while the diminished sick list amply testifies to the better sanitary condition of the sailor's dwelling.

To illustrate the necessity that exists for improving Ventilation in ships, and to preserve them from premature decay, I may refer to the observations of eminent writers on ship-building. Murray remarks that the means at our command for the purpose of preserving timber from premature decay may be summed up in two words—Seasoning and Ventilation—thorough drying of the timber on shore, when practicable; but by all means good Ventilation on board. If these well-known and universally approved principles were properly carried out, we should hear but little of rotten gunboats, or hasty repairs to frigates after a first commission. What is most urgently required is, that there shall be as little stagnation of air as possible. However well seasoned and dry the timber may be when a vessel is launched, it will rapidly absorb moisture from the damp atmosphere of the hold, unless evaporation from its surface be kept up by a forced circulation of air. The beneficial effects of Dr. Hales' system of Ventilation were evidenced by the fact that from 1753, when it was first employed in the old "Prince," to 1798, when the use of it was discontinued, the durableness of ships was materially improved, as well as the health of the crews of those ships to which it was applied, especially transports.

The Earl of Halifax, in a letter to Doctor Hales, stated that the mortality of the ships on the coast of Nova Scotia which were not ventilated was, in comparison with those which were, as twelve to one. Doctor Hales proposed to keep up a circulation of air with windmills and air-pumps. Mr. Parkins followed his system, substituting fans.

But what is most urgently required has not yet been practically realized—the producing a constant disturbing force on the lower part of the hold, which should give motion to the foul air that has a natural tendency to lodge there, while suitable means are, at the same time, in operation for carrying it off, and supplying its place by the introduction of pure air. The constant operation of some means to produce this effect is necessary for the preservation of ships, the health of the crew, and the ship's stores.

The introduction of pure and dry air into the hold is requisite to carry off the humid particles which adhere to the interior of a ship, and excite the latent elements of decay, which, under circumstances favourable to their development, are soon apparent.

Fincham, in his "Outlines of Ship-Building," remarks that it is in the hold of a ship, more than in any other part, that the destructive agents accumulate—moisture and impure air, arising from the decomposition of animal and vegetable substances which fall into the hold, or accumulate from the defective manner of stowing ships. The want of proper ventilation will produce the most serious results to the health of the crew and the condition of the ship.

To accomplish what is desired, a system of Ventilation is needed which will insure a pure atmosphere in every part of the hold, and between the decks. In order to prevent the destructive effects of air-heat and moisture, and to produce thorough Ventilation, some disturbing force should be employed. It being thus evident that persons best qualified to form an opinion on the subject conceive that an efficient system of ship Ventilation is necessary for the preservation of ships from decay by dry rot, and as a means for preserving the health and promoting the comfort of passengers and crews; for as damp and insufficient Ventilation cause the destruction of the ship, so they prove equally injurious to the health of her occupants; and if an effectual remedy can be found for dry rot by removing its causes, by the same means will the ship also be rendered healthy. The inventor of the system of Ventilation which I now submit for your consideration has, I think, accomplished what has been so long required.

Doctor Edmunds, Staff-Surgeon in the Royal Navy, has had his attention strongly directed towards the subject of Ventilation by painful experience of disease and discomfort arising from the inefficient and uncertain measures usually adopted to lessen the stagnation of air in the close and confined decks of vessels of war. The construction of a ship, which is often considered to oppose so many obstacles to free Ventilation, in Doctor Edmunds' opinion, in reality offers facilities which are now for the first time made available by his invention. The important object is attained by means of a novel system of air shafts and channels, through means of which the perfect Ventilation of the ship's timbers and of the inhabited decks and cabins is secured. It is well known that dry rot, or decay misnamed dry rot, is caused by dampness of the timber surfaces forming principally the sides of the openings or timber spaces, which are close channels leading up from the bilges at the bottom of the hold; these have a vent in the between-decks; and it is for the purpose of their ventilation, to prevent decay or dry rot in the timbers, that they are left open; otherwise, but for so important an object, such a source of foul smells, malaria, and consequent disease, would never have been allowed so long to pollute and poison the air of a confined space in which so many have to live and breathe.

It would be a parallel case if persons on shore inhabited a crowded apartment, into which the foul air from a damp underground cellar, with drains running through, had vent by numerous open channels; but the passive circulation which takes place is insufficient for the purpose intended. The openings are usually in a damp state; and any timber employed in the ship's framework, if not well seasoned, is sure to decay. The premature decay of the gunboats hastily built during the Russian War is conclusive evidence of this. By the first part of the new system the operation of these openings or channels is reversed; they are converted from their present action of fouling the air into most effectual means for purifying it. This is effected by making them all branch air channels of one large airshaft on each side of the ship, which being led into the funnel in steamers, or into hollow iron masts or tube and cowl ventilators in sailing vessels, a constant updraught is created through them up from the bilges and hold, and down from the mess deck, to the shaft, carrying all their foul contents into the open air, preventing contamination from the bilges and hold by creating a constant current of air flowing through the timber spaces. The timbers will be effectually ventilated, and dry rot prevented. Probably, even if the ship were built of unseasoned timber, all endemic causes of disease existing in the ship, and which occasionally cause, or at least promote, the ravages of fevers in tropical climates, will be removed by this plan. In most cases of malignant fevers occurring on board ships in the Royal Navy, the bilges and timber spaces have been found choked with decaying matter; and there can be no doubt that in the mercantile marine similar causes prevail, with leakage from cargo superadded.

In the Reports of the Social Science Association, it is stated that, notwithstanding the great advantages of selection, diet, and discipline enjoyed by the Royal Navy, the rate of mortality is much above the civil population; whereas, from the healthful life led by sailors, being removed to a great extent from many causes of disease, we might fairly expect them to enjoy better health. To complete the Ventilation of the decks, channels are provided. These are nothing more than the substitution of a strongly constructed air channel, in place of one or more of the planks forming the ceiling on each side of the deck to be ventilated. These planks vary in thickness from three to five inches, in a channel of the same depth, and from eight to twelve inches in width, in proportion to the size of the ship, and can be constructed so that the iron plate completing the channel above may also act as a stringer plate, greatly increasing the longitudinal strength of the ship. It occupies no apparent space, and is in the best possible position for ventilating the decks, as it acts immediately upon the air between the beams where all the foul, heated, and rarified air collects. The deck channels are ventilated similarly, with openings into the main shaft. Together they form a perfect system of Ventilation in steam ships, as nearly as possible self-acting, available where Ventilation is most needed, and causing no draught, as the action is diffused by communicating cross channels, two sides of each being formed by a portion of the cross beam and the deck, completed by a thin wooden batten perforated with holes. It will be seen that this system promotes natural Ventilation, through aiding the escape of foul air, and providing outlets in the most convenient places for it. The funnel draught is most powerful at all times, but particularly when steam is up. Hollow iron masts, forming three outlets for discharge, are equally effectual in steam or sailing vessels, as they have a constant powerful updraught. Tube and cowl ventilators in connexion with these shafts are available in sailing ships, with the advantage of being used either as uptakes, or, when a fresh dry wind is blowing, the cowl may be faced to the wind, when a stream of pure air will be forced through the ship. By either mode the deck atmosphere will be rendered pure. But, as a rule, Ventilation by exhaustion is to be preferred. Pure air will naturally take the place of the foul, admitted through hatchways, ports, and scuttles. Other means of Ventilation are also available in connexion with this system of shafts, such as a steam jet, fans worked by hand, or a fire draught otherwise applied. With this plan of Ventilation, the practice of stuffing the timber spaces with tons of salt, or other protecting substances against dry rot, is totally unnecessary. The existence of foul air in the hold, damaging cargo, as well as causing disease and discomfort, is impossible. The shafts and channels are of easy construction, and, once established, are always available.

Doctor Edmunds' system has already been introduced, by order of the Lords Commissioners of the Admiralty, on board Her Majesty's ship "Royal Sovereign;" the "Zealous," iron-cased frigate; and the "Favourite." Although under great disadvantages as regards Ventilation, necessarily attendant upon their construction, and not having side ports or scuttles, still they will be undoubtedly the best and most healthfully ventilated ships ever built. With respect to the application of his system of Ventilation to emigrant ships, I have received from Doctor Edmunds the following observations:—"Of all classes of ships in which Ventilation requires the most careful consideration, emigrant vessels occupy the first place. In them we have large numbers of helpless men, women, and children, mostly for the first time in their lives crowded together in the narrow decks of a ship; unused to the motion of a vessel, they become physically prostrate, and mentally depressed; and, but for the excellent rules of Her Majesty's Emigration Service, carried out under the direction of experienced medical officers, their condition would soon become most deplorable. But even under present advantages it has been found impossible to effect perfect Ventilation of those crowded decks. Effluvia from the hold still further contaminate the air already vitiated to a great extent, particularly in calms and in bad weather, when it is necessary to close the hatches more or less. It is at these times that the foul air from the holds and bilges becomes most apparent and injurious, collecting chiefly in the highest part of the deck. It is only under exceptional circumstances that the carbonic acid evolved by the lungs or generated by vegetable decay escapes."

Most of the endeavours to ventilate ships have been directed to supply fresh air chiefly by windsails, but they are too uncertain; and in calms, when most needed, are valueless. Those only who have been becalmed in an emigrant ship on the Equator can fully comprehend the stagnation of air which prevails, particularly during the prevalence of heavy rains, which compel the passengers to remain below. The introduction of air in the ordinary way cannot be always accomplished without creating an amount of damp and discomfort, especially to those berthed in the vicinity of the windsails; and nothing is more common than to find the mouths tied up, passengers preferring the close and vitiated atmosphere to a cold damp draught from the windsail. When we remember that the apertures in the ship's lining are at the same time discharging the foul air from the hold, we can understand the utility of enclosing those openings in the longitudinal tube connected with the perpendicular air shaft, which conducts the objectionable air into the atmosphere. As the heated and vitiated air escapes through the cowl-headed ventilator, cool and pure air occupies its place in the hold and between decks, so long as there is any wind. During calms it is necessary to have some supplemental means of keeping up a circulation of air throughout the ship: a steam jet here becomes a valuable and powerful auxiliary, always available when the aërial current fails us.

The steam jet is directed into the shaft, and escapes through the cowl ventilator, which when steam is used must be turned from the wind; it should be placed near the centre of the ship, and for a vessel of 1000 tons ought to be two feet in diameter. Through this every up-current of one foot per second velocity will discharge 10,800 cubic feet per hour of foul air—with a breeze blowing, the velocity will be about ten feet per second; this is amply sufficient to renew thoroughly the vital air in every part of the structure, without creating the least perceptible draught. During the day the air is drawn equally from the passenger deck, hold, and bilges, but at night almost exclusively from the passenger deck, the hatches communicating with the hold being then closed. The respiration of an individual during one hour is estimated at about ten cubic feet, the quantity mentioned as carried off; and an equal quantity of fresh external air introduced is at the rate of 400 cubic feet per hour for each of 250 individuals. The source of the steam jet in vessels propelled by sails is the condenser. The difficulty of stowing sufficient water in a ship for a long voyage has led to the use of distilled water, which is found, when properly aërated, to be perfectly sweet and wholesome; therefore a distilling apparatus is provided in Government emigrant ships, from which a supply of steam can always be obtained, of course diminishing the quantity of condensed water, which a few additional hours' distilling will compensate for, and will, in lieu, create at the time of the greatest need a "circulation of air" of vital consequence to the health of the emigrants. The action of a jet of steam is well known to carry up with it a quantity of air in proportion to the pressure from which it is liberated: a half-inch jet at 20 lbs. pressure, escaping at the rate of 2000 feet per second, led up a ventilator of two feet diameter, will exhaust the air through it at a velocity of twenty feet per second. But, though this is the manner in which it has been hitherto used, one-fourth the quantity of steam divided into a number of minute jets will create a draught of equal strength, with the additional advantage that the escape of steam is almost silent, whereas a large jet creates considerable noise. It will be seen that this velocity of 20 feet per second circulates upwards of 20,000 cubic feet of air per hour, double that caused by the unaided action of the wind, and at a time when such increased Ventilation is so much needed. In iron ships, where timber spaces do not exist, or some vessels of war in which they are blocked up, the deck channel becomes available as a perfect means of communication with the mess deck. In steamers, the necessary updraught is created by connecting the shaft with the funnel, up which there is always a draught of from four to eight feet per second; and when steam is up, from twenty to twenty-five. Hollow iron masts, which are now coming into very general use, are valuable ventilators in connexion with this system; they have a constant updraught of from four to ten feet per second. Doctor Edmunds has recently received a report of the practical working of the system, first employed in the "Royal Sovereign," in 1863, for the Ventilation principally of the ship's framework, otherwise totally unprovided for; it answers this purpose perfectly, removing all foul smells from the bilges, and keeping the air of the between-decks pure; its utility is proved by their foul state returning whenever its action is suspended. Captain Sherard Osborne writes:—"I consider your apparatus well qualified to ventilate the decks of ships devoid of scuttles or ports, and I attribute to it much of the health and comfort my crew enjoyed in 'the Royal Sovereign.' Doctor Elliott, Surgeon of the ship, states:—'I have much pleasure in bearing testimony to your system of Ventilation, which has acted so thoroughly in removing the foul air from the bilges and hold of this ship; I consider it one of the best sanitary measures introduced on board Her Majesty's ships.' The Admiralty have directed Doctor Edmunds to prepare plans for most of the ships now being built. In the commencement of the year 1864, Her Majesty's Emigration Commissioners, ever anxious to make the Ventilation and other arrangements of their ships as perfect as possible, permitted Doctor Edmunds to carry out his system in three of the ships taken up by them—the 'Art Union,' the 'Earl Russell,' and the 'General Caulfield.'"

The Report upon the working of the system specially required by the Commissioners has established its success. The surgeon superintendent of the "Earl Russell" reported to the Commissioners that it was the most perfect system of Ventilation in theory and practice he had ever seen. Dr. Carroll of "The Art Union," in the course of an elaborate analysis of its effects, states that in the hot latitudes he found the temperature between decks lower than he had ever before experienced; very little unpleasant smell was observable in the between-decks, and the heated and foul air that is usually observed arising at night and from the deck ventilators was in this instance absent. In the calms about the Equator the steam jet was much used; the temperature during its use was reduced, and a very perceptible draught created, evinced by holding a candle at the air holes, and the strong current observable at the cowl head. In "The General Caulfield," in which ship I had an opportunity of testing Dr. Edmunds' apparatus, the results were fully in accordance with the foregoing statements. While the steam jet is in operation very little water can be obtained from an apparatus capable of distilling 500 gallons of water per day of twelve hours. An extra quantity of coal must therefore always be estimated for; I should say about ten tons, the cost of which is quite insignificant in comparison to the valuable results accruing from the use of this apparatus. In a sanitary point of view, independent of the use of the steam jet, and depending on the wind, I consider it a vast improvement, superior to any other system of Ventilation I have ever examined in the course of my experience in superintending emigrant and passenger ships; and I can only conclude that in Dr. Edmunds' method we have every requirement to insure the effective Ventilation of vessels of war and passenger ships. In directing its adoption generally in the ships taken up for the conveyance of emigrants, Her Majesty's Emigration Commissioners have not only conferred a great boon on these poor people, by making their temporary abode upon the waters more healthful and agreeable, but the ships will also, in consequence of their timbers being kept dry and ventilated, resist the dry rot, and last longer—although this in the eyes of the philanthropist is a very secondary consideration to the preservation of life and health at sea. By conducting the steam jet into the ventilator we increase the current, and thereby discharge the foul air more rapidly—the conclusion arrived at being, that if we succeed in discharging the foul air, the vacant space will be occupied by pure. In the case of steamers we conduct the channel into the funnel, or, if preferred, connect it with the fireplace. As to the adaptability of the system for ventilating houses, I think a very simple arrangement would prove effective, by lifting some of the boards in each room, and converting the space between the joists into a box three sides air-tight, the bottom perforated with minute apertures penetrating through the ceiling of the room below, the air box to communicate through the medium of a tube with the flue, the updraught in which would be precisely similar to the funnel draught in steamers. By this simple arrangement the flues of rooms, at all times valuable ventilating agents, will be rendered more perfectly so, and the heated air of a room, ascending to the ceiling, more effectually carried off. To a certain extent, also, I should imagine this arrangement would be a remedy for smokey chimneys. To insure a supply of pure air, not generally obtainable in close narrow streets inhabited by a large population of the working classes, I would suggest an opening in the ceiling of the top landing, terminating in a cowl ventilator on the roof, arranged to turn with and towards the direction of the wind. This would insure the purest air obtainable being supplied to the staircase, hall, and passages. In the skirting board of the rooms the insertion of a perforated plate would admit this purer atmosphere. I should be glad to have the opinion of practical men as to the expense of this ventilating arrangement. I cannot think it would amount to more than a few pounds; and surely the owners of property let in tenements would not hesitate, if this may be deemed an important sanitary measure, to tax themselves in a small degree to increase the health, promote the happiness, and prolong the lives of a large and important section of the community.

INDEX.

Andrews, William, on the sea fisheries of Ireland, and with reference to trawling, 1.
—— further notes on salmonidæ, 30.
Abnormal morphological developement of the common snowberry, on the, by A. Macalister, M. D., 97.
Account of Ogham inscriptions in the cave at Rathcroghan, Co. Roscommon, by Samuel Ferguson, 99.
Antiquities and human remains found in the county of Down in 1780, on the, by Sir William Wilde, 267.
Archer, William, record of the occurrence, new to Ireland, with note of a peculiar condition of the volvocinaceous alga *Stephanosphæra pluvialis* (Cohn), 65.
—— description of a new species of Docidium (Bréb.) from Hong-Kong, 98.
Atlantic cable, on the construction of the, by Harry N. Draper, 286.

Baily, on some new points in the structure of Palæchinus, 261.
—— some additional notes on the structure of Palæchinus, 263.
Barker, John, M. D., notes on some dissections of the fresh water pearl mussel (*Unio margaritifera*), 62.
Barometer, on a new table and formula for determining altitudes with the, by Stephen M. Yeates, 284.
Barry, J. M., M. D., on the icebergs of the Southern Hemisphere, 271.
—— on Dr. Edmunds' system of ventilation for the purpose of improving the sanitary condition of ships, and preserving them from decay; with suggestions as to its applicability for the purpose of ventilating crowded dwelling houses, 343.
Blyth, —, remarks on pigeons, &c., 32.
Bog, some hints on the successful reclamation of, by George Ellis, 171.

Cameron, Charles A., M. D., on the chemical composition and fertilizing value of the sewage of Dublin, 322.
—— discussion on the foregoing paper, 340.
Catalogue of the mammalian fossils which have been hitherto discovered in Ireland, by Robert H. Scott, 49.
Chemical value of manures, on the, and the Silurian limestone of Courtown Harbour, county of Wexford, 280.
—— composition and fertilizing value of the sewage of Dublin, on the, by Charles A. Cameron, M. D., 322.
Close, Rev. Maxwell H., notes on the general glaciation of the rocks in the neighbourhood of Dublin, 177.

Davy, E. W., M. D., on flax, and the practicability of extending its cultivation in Ireland, &c., 144.
Dublin, on the chemical composition and fertilizing value of the sewage of, by Charles A. Cameron, M. D., 322.
Docidium (Bréb.), description of a new species of, from Hong-Kong, by William Archer, 98.
Donegal, notes on the physical features of the county of, by W. Harte, 195.
—— on a new Echinoderm from the yellow sandstone of, by William Harte, 265.
Down, antiquities and human remains found in the county of, in 1780, by Sir William Wilde, 267.
Doyle, J. B., notes on the occurrence of a well-marked specimen of Knorria in the lower carboniferous limestone series of Kildare, 187.

Draper, Harry N., on the construction of the Atlantic cable, 286.

Echinoderm, on a new, from the yellow sandstone of Donegal, by W. Harte, 265.
Edgeworth, Richard L., on Irish vespidæ, 40.
Ellis, George, M. B., some hints on the successful reclamation of bog, 171.
Erratic block, on a recent, by F. J. Foot, 192.

Ferguson, Samuel, account of Ogham inscriptions in the cave at Rathcroghan, county of Roscommon, 99.
Flax, on, and the practicability of extending its cultivation in Ireland, by E. W. Davy, M. D., 144.
Flights of swans seens in the counties of Roscommon and Galway, during the winter of 1863, 1864, by F. J. Foot, 60.
Foot, F. J., on the occurrence of the *Hymenophyllum Tunbridgense* (Smith) in the county of Longford, with a list of stations of *Cystopteris fragilis* (Bernh.), in the Midland Counties, 57.
—— on flights of swans seen in the counties of Roscommon and Galway, during the winter of 1863–64, 60.
—— on a recent erratic block, 192.
Fossils, mammalian, which have been hitherto discovered in Ireland, catalogue of, by Robert H. Scott, 49.
—— some remarks on the doctrine of characteristic fossils, by John Kelly, 232.
Fresh water pearl mussel (*Unio margaritifera*), notes on some dissections of the, by John Barker, M. D., 62.

Galway, on a polished and striated surface in the limestone of Ross Hill, county of, by M. H. Ormsby, 201.
Geological notes on some of the islands of the west of Scotland, by the Rev. Samuel Haughton, M. D., 93.
Geology of the New Zealand Gold-Fields, on the, by W. Lauder Lindsay, M. D., 247.
Glaciation of the rocks in the neighbourhood of Dublin, notes on the general, by the Rev. M. H. Close, 177.
Granite, on a new locality of, in limestone near Rathfarnham, by H. B. S. Montgomery, 189.

Harte, W., notes on the physical features of the county of Donegal, 195.
Harte, on a new Echinoderm from the yellow sandstone of Donegal, 265.
Haughton, Rev. Samuel, M. D., on the death of the lion and ostrich in the Royal Zoological Gardens of Dublin, 35.
—— discussion on foregoing paper, 38.
—— geological notes on some of the islands of the west of Scotland, 93.
—— notes on animal mechanics:—No. 3, on the muscular mechanism of the leg of the ostrich, 204.
—— No. 4, on the muscular anatomy of the lion, 216.
—— No. 5, on the muscular anatomy of the seal, 224.
Hymenophyllum Tunbridgense (Smith), in the county of Longford, with a list of stations of *Cystopteris fragilis* (Bernh.) in the Midland Counties, by F. J. Foot, 57.

Icebergs, on the, of the Southern Hemisphere, by J. M. Barry, M. D., 271.
Irish vespidæ, on, by Richard L. Edgeworth, 40.

Jones, Admiral T., on the occurrence of spiral vessels in the thallus of *Evernia prunastri*, (Ach., Linn. sp.), 91.
—— report on the progress made in collecting the Irish lichens, accompanying a presentation to the Natural History Society of a complete series of specimens of those hitherto collected, 109.
Jukes, J. Beete, notes for a comparison between the rocks of the south-west of Ireland, and those of North Devon, and of Rhenish Prussia (in the neighbourhood of Coblentz), 287.

Kelly, John, some remarks on the doctrine of characteristic fossils, 232.
Knorria, notes on the occurrence of a well-marked specimen of, in the lower carboniferous limestone series of Kildare, by J. B. Doyle, 187.

Lichens, Irish, report on the progress made in collecting the, by Admiral T. Jones, 109.
Limestone of Ross Hill, county of Galway, on a polished and striated surface in the limestone of, by M. H. Ormsby, 201.
Lindsay, W. Lauder, M. D., on the geology of the New Zealand Gold-Fields, 247.

Lion, on the muscular anatomy of the, by the Rev. Samuel Haughton, M. D., 216.
—— and ostrich, on the death of, in the Royal Zoological Gardens of Dublin, by the Rev. Samuel Haughton, M. D., 35.
—— discussion on foregoing paper, 38.

Macalister, Alexander, M. D., on an abnormal morphological developement of the common snowberry, 97.
—— on a remarkable specimen of Ulodendron, found at Hurlet, Renfrewshire, 190.
Mammalian fossils in Ireland, catalogue of, by R. H. Scott, 49.
Manures, on the chemical value of, and the Silurian limestone of Courtown Harbour, county of Wexford, by George Waller, 280.
Montgomery, Henry B. S., on a new locality of granite in limestone near Rathfarnham, 189.

New table and formula for determining altitudes with the barometer, on a, by Stephen M. Yeates, 284.
New Zealand gold-fields, on the geology of the, by W. Lauder Lindsay, M. D., 247.
Notes on some dissections of the fresh water pearl mussel (*Unio margaritifera*), by John Barker, M. D., 62.
—— geological, on some of the islands of the west of Scotland, by Rev. Samuel Haughton, M. D., 93.
—— on the occurrence of a well-marked specimen of Knorria in the lower carboniferous limestone series of Kildare, by J. B. Doyle, 187.
—— on the physical features of the county of Donegal, by W. Harte, 195.
—— on animal mechanics, by the Rev. Samuel Haughton, M. D.:—
    No. 3, on the muscular mechanism of the leg of the ostrich, 204.
    No. 4, on the muscular anatomy of the lion, 216.
    No. 5, on the muscular anatomy of the seal, 224.
—— for a comparison between the rocks of the south-west of Ireland and those of North Devon, and of Rhenish Prussia (in the neighbourhood of Coblentz), by J. Beete Jukes, 287.

Occurrence, on the, of *Hymenophyllum Tunbridgense* (Smith) in the county of Longford, with a list of stations of *Cystopteris fragilis* (Bernh.) in the Midland Counties, by F. J. Foot, 57.
Occurrence, on the, of spiral vessels in the thallus of *Evernia prunastri*, by Admiral T. Jones, 91.
Ogham inscriptions in the cave at Rathcroghan, county of Roscommon, account of, by Samuel Ferguson, 99.
Ormsby, M. H., on a polished and striated surface in the limestone of Ross Hill, county of Galway, 201.
Ostrich, on the muscular mechanism of the leg of the, by the Rev. Samuel Haughton, M. D., 204.
—— and lion, on the death of, in the Royal Zoological Gardens of Dublin, by the Rev. Samuel Haughton, M. D., 35.

Palæchinus, description of a new, by Joseph Wright, 260.
—— on some new points in the structure of, by W. H. Baily, 261.
—— some additional notes on the structure of, by W. H. Baily, 263.
Pigeons, &c., remarks on, by — Blyth, 32.

Record of the occurrence, new to Ireland, with note of a peculiar condition of the volvocinaceous alga *Stephanosphæra pluvialis* (Cohn), by William Archer, 65.
Report of the progress made in collecting the Irish lichens, by Admiral T. Jones, 109.
Rocks, notes on the general glaciation of the, in the neighbourhood of Dublin, by the Rev. M. H. Close, 177.
—— of the south-west of Ireland, notes for a comparison between the, and those of North Devon, and of Rhenish Prussia (in the neighbourhood of Coblentz), by J. B. Jukes, M. A., 287.

Salmonidæ, further notes on, by William Andrews, 30.
Scott, Robert H., catalogue of the mammalian fossils which have been hitherto discovered in Ireland, 49.
Sea fisheries of Ireland, and with reference to trawling, on the, by Wm. Andrews, 1.
Seal, on the muscular anatomy of the, by the Rev. Samuel Haughton, M. D., 224.
Sewage of Dublin, on the chemical composition and fertilizing value of the, by C. A. Cameron, M. D., 322.

Spiral vessels in thallus of *Evernia prunastri*, on the occurrence of, by Admiral T. Jones, 91.

Swans, on flights of, seen in the counties of Roscommon and Galway, during the winter of 1863–64, by F. J. Foot, 60.

Ulodendron, on a remarkable specimen of, found at Hurlet, Renfrewshire, by Alexander Macalister, M. D., 190.

Vespidæ, on Irish, by Richard L. Edgeworth, 40.

Ventilation, on Dr. Edmunds' system of, by J. M. Barry, M. D., 343.

Volvocinaceous alga *Stephanosphæra pluvialis* (Cohn), record of the occurrence, new to Ireland, with note of a peculiar condition of the, by W. Archer, 65.

Waller, George, on the chemical value of manures, and the Silurian limestone of Courtown Harbour, county of Wexford, 280.

Wilde, Sir William, on the antiquities and human remains found in the county of Down in 1780, 267.

Wright, Joseph, description of a new Palæchinus, 260.

Yeates, Stephen M., on a new table and formula for determining altitudes with the barometer, 284.

INDEX TO PLATES.

Page

Plate I. . . Illustrative of Record of the Occurrence, new to Ireland, with Note of a peculiar Condition of the Volvocinaceous Alga *Stephanosphæra pluvialis* (Cohn), and Observations thereon. By William Archer, ... 65

Plates II., III., IV. Illustrative of Paper on the Sea Fisheries of Ireland, and with reference to Trawling. By William Andrews, M. R. I. A., President of the Natural History Society of Dublin, ... 1

Plate V. . . Illustrative of Notes on the general Glaciation of the Rocks in the Neighbourhood of Dublin. By the Rev. Maxwell H. Close, 177

Plate VI. . Illustrative of Notes on the Physical Features of the County of Donegal. By W. Harte, C. E., ... 195

Plate VII. Illustrative of Description of a New Palæchinus. By Joseph Wright, ... 260

Plate VIII. Illustrative of some New Points in the Structure of Palæchinus. By William Hellier Baily, F. G. S. & L. S., ... 261

Plate IX. . . Illustrative of a New Echinoderm from the Yellow Sandstone of Donegal. By William Harte, C. E., ... 265

END OF VOL. V.

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CONTENTS OF No. XX.—OCTOBER, 1865.

WITH THREE PLATES.

PAGE

1. The Icebergs of the Southern Hemisphere. By J. M. Barry, M. D., L. R. C. P. D., L. R. C. S. I., M. R. D. S., M. R. Z. S., &c. &c., . . . 271

2. On the Chemical Value of Manures, and the Silurian Limestone of Courtown Harbour, County of Wexford. By Geo. Waller, C. E., 280

3. On a New Table and Formula for determining Altitudes with the Barometer. By Stephen M. Yeates, ... 284

4. On the Construction of the Atlantic Cable. By H. N. Draper, . . 286

5. Notes for a Comparison between the Rocks of the South-west of Ireland and those of North Devon, and of Rhenish Prussia (in the Neighbourhood of Coblentz). By J. Beete Jukes, M. A., F. R. S., ... 287

6. On the Chemical Composition and Fertilizing Value of the Sewage of Dublin. By Charles A. Cameron, M. D., Analyst to the City of Dublin, ... 322

7. Dr. Edmunds' System of Ventilation, for the purpose of Improving the Sanitary Condition of Ships, and Preserving them from Decay; with Suggestions as to its Applicability for the Purpose of Ventilating crowded Dwelling-houses. By Dr. J. M. Barry, L. R. C. P. D., L. R. C. S. I., M. R. D. S., M. R. Z. S., ... 343

Index, ... 351

Index to Plates, ... 354

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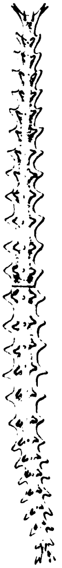
1.



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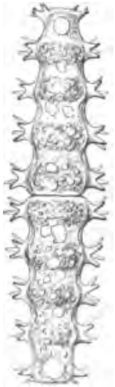

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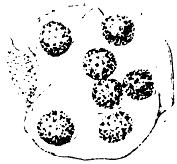

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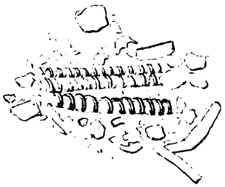

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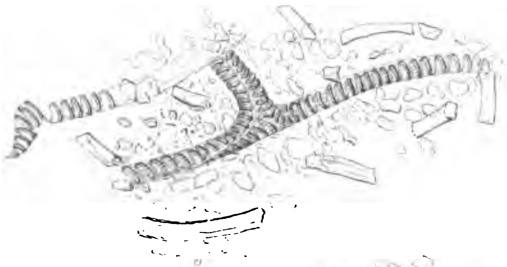

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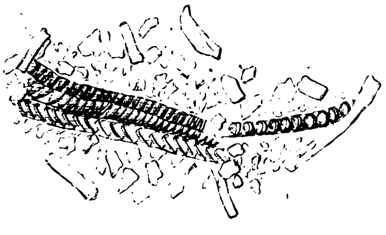

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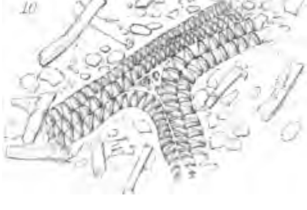

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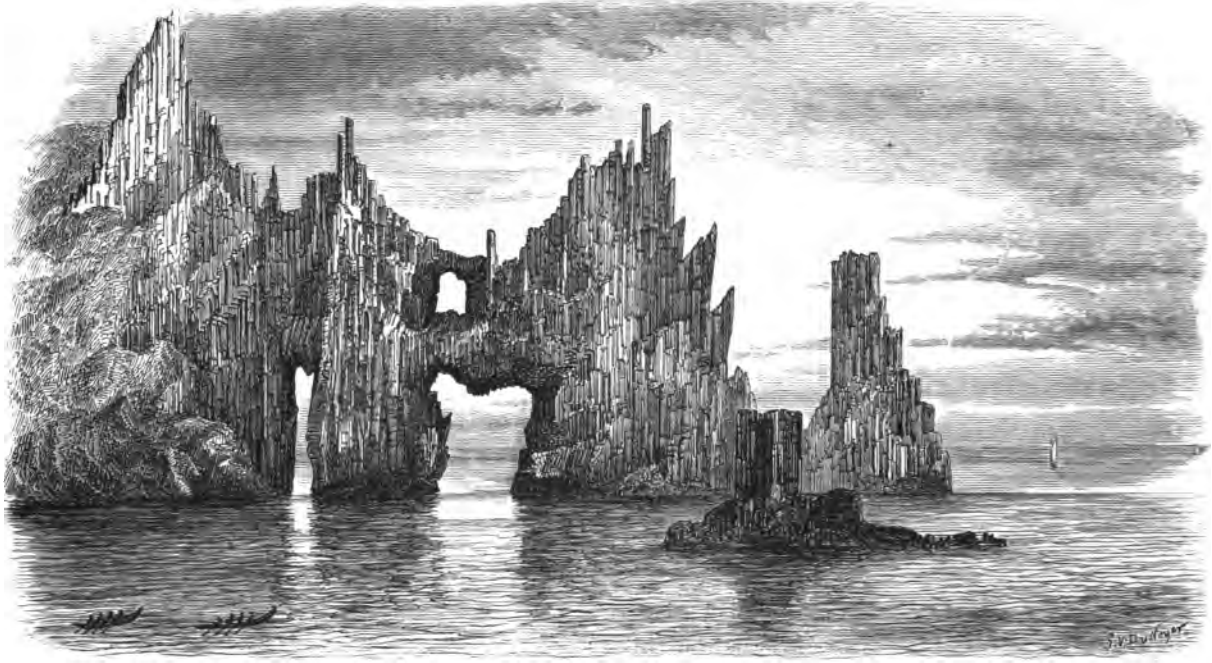
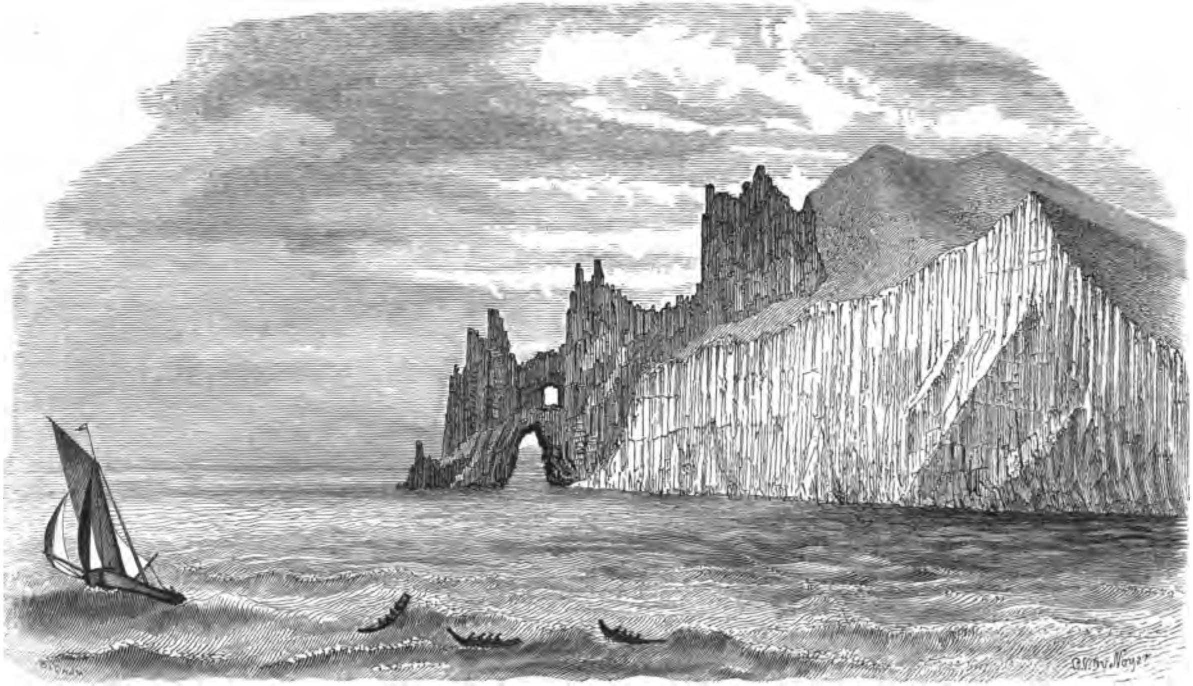
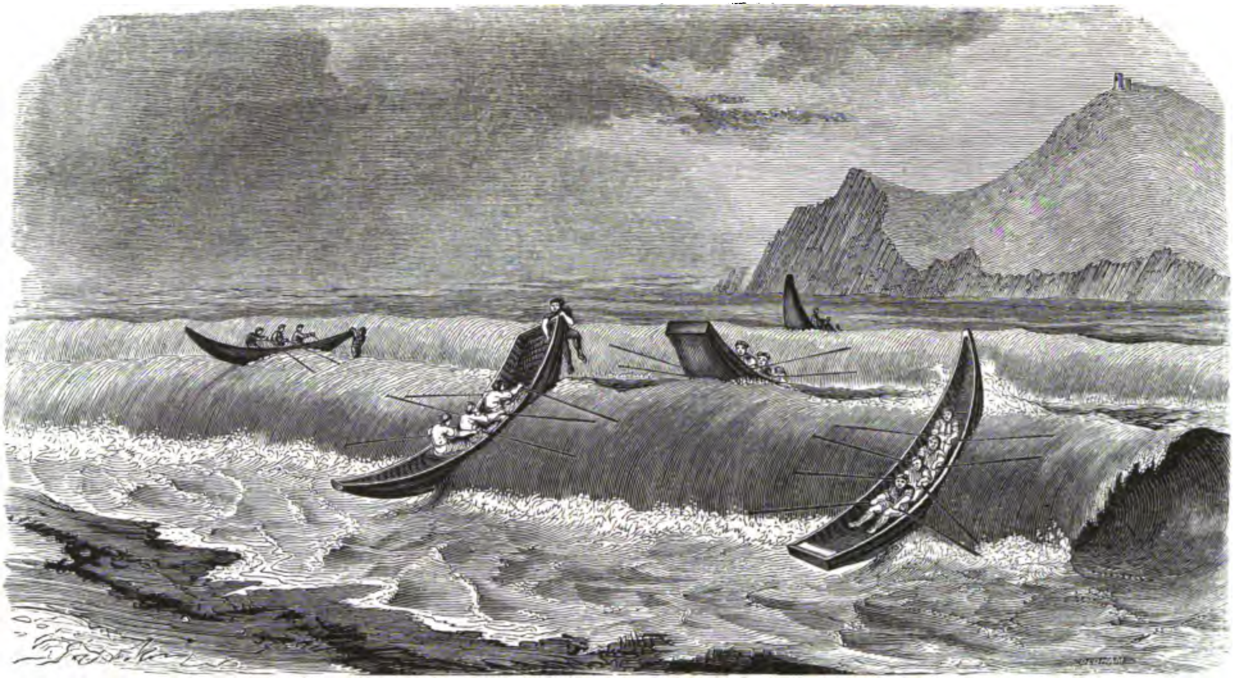


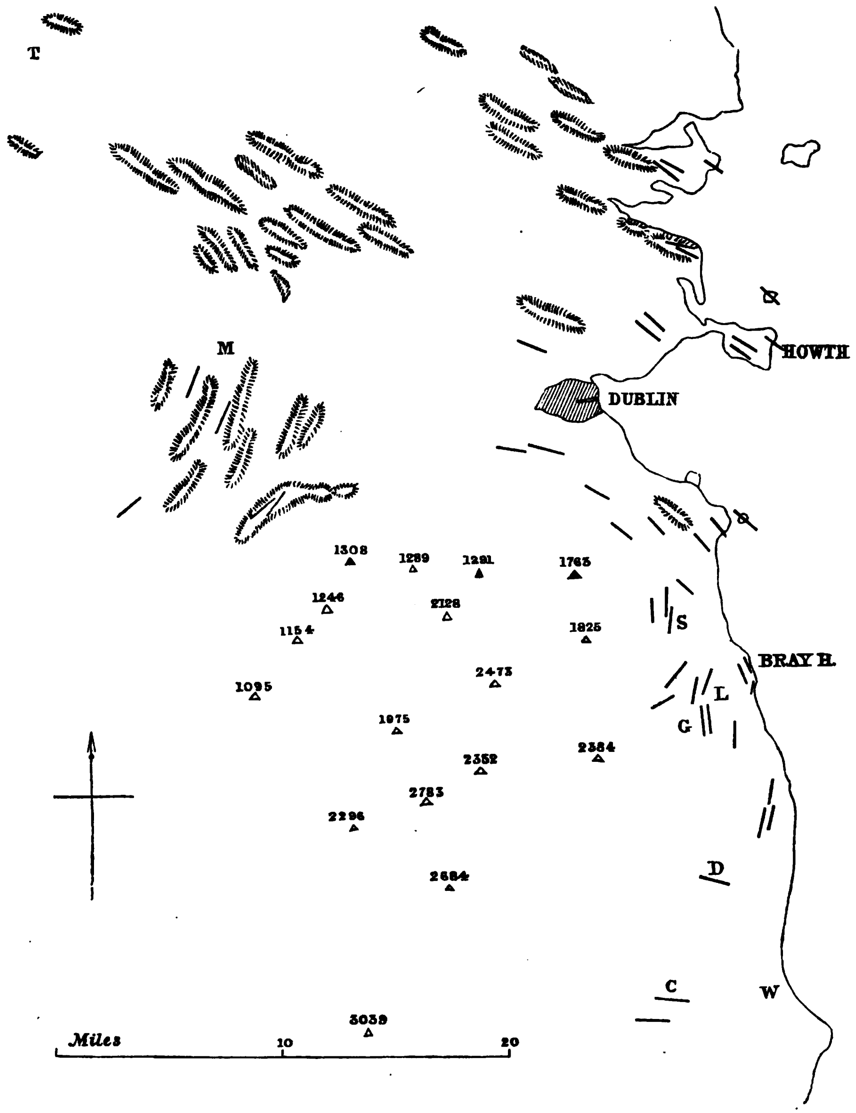
No. 1.—TO ILLUSTRATE MR. ANDREWS' PAPER ON THE SEA FISHERIES OF IRELAND.





No. 3.—TO ILLUSTRATE MR. ANDREWS' PAPER ON THE SEA FISHERIES OF IRELAND.

CORRAGHS BEACHING IN SMERWICK BAY, COAST OF KERRY. BALLYDAVID HEAD, EASTERN ENTRANCE OF THE BAY.



MAP OF GLACIAL PHENOMENA NEAR DUBLIN.

The short strokes give the directions of the rock-striations. On this small scale the ridging can only be represented diagrammatically.

S.	Summit of	Shankill,	912 ft.	M.	Maynooth.
G.	,,	Great Sugar-loaf,	1659	W.	Wicklow.
L.	,,	Little do.	1120	T.	Trim.
D.	,,	Dunran Hill,	1122		
C.	,,	Carrick Hill,	1252		

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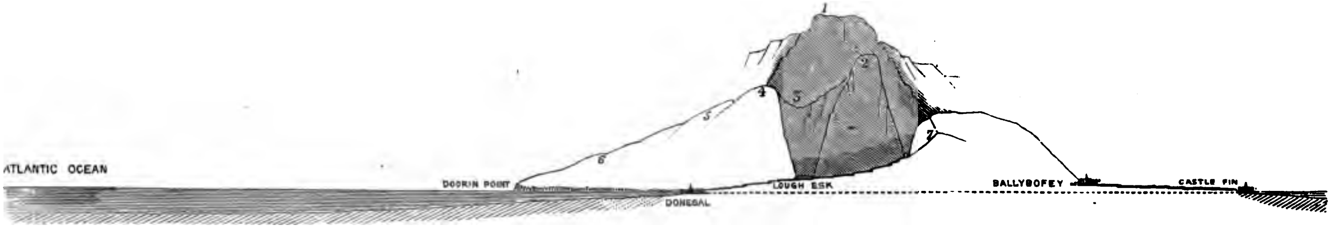

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4. Barnes Mountain, 1275 feet.
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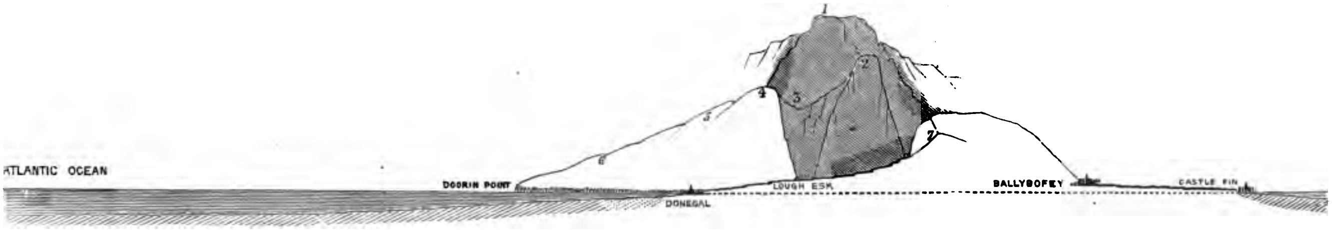

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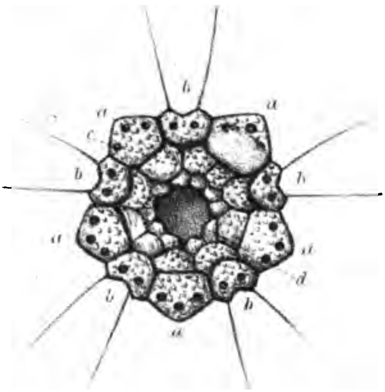

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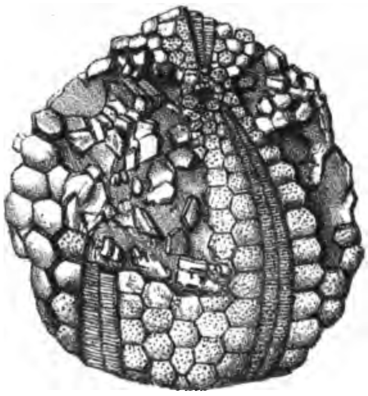

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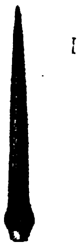

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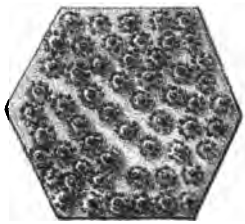

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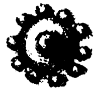

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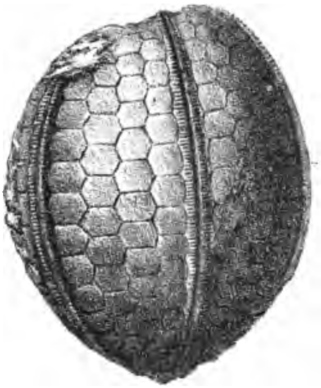

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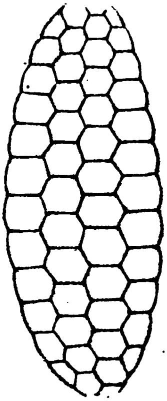

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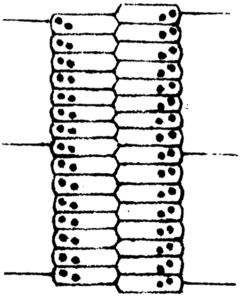

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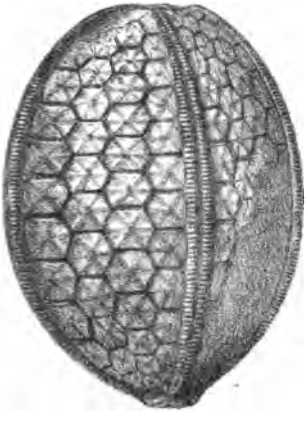

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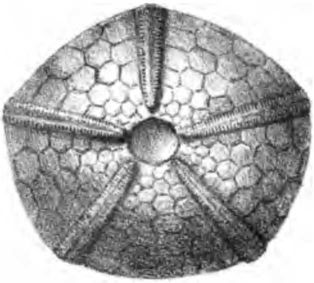

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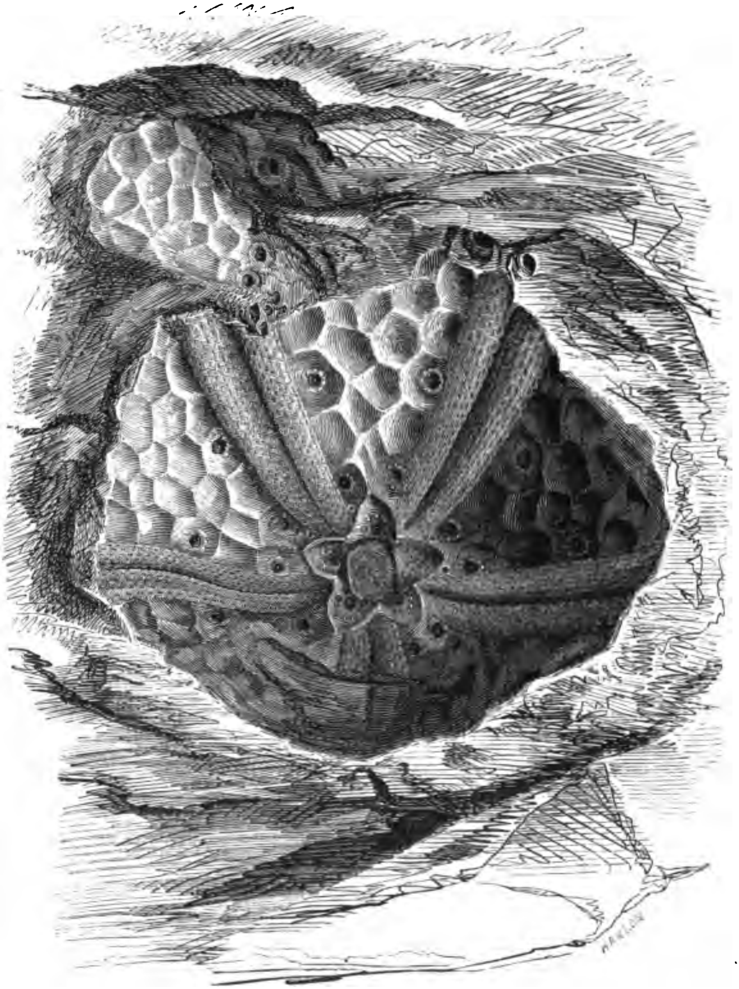

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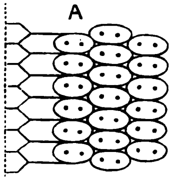
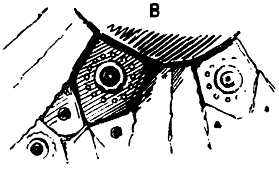


A. Portion of ambulacral space, enlarged.



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